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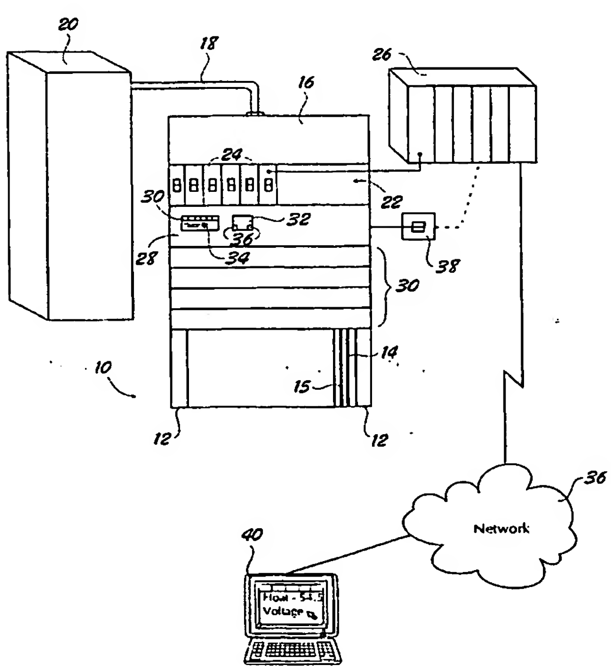

(57) Abstract: The modular master control unit of the telecommunications power system communicates via a data bus with the associated modular rectifier units, distribution unit(s) and battery connection unit(s) to collect operating state information from the neuron processors of those units and store that information in a database. The master control unit also controls the operation of the associated modular units by supplying operating state information, based on values stored in the database. The user interface manager module provides local user interface control over the system by allowing the user through a local display screen and touch pad to read from and write to the database. By downloading an applet to a remote computer running a web browser, the user interface manager allows users at remote locations to perform the same control and monitor functions as a user at the local site. The applet runs within the standard browser and communicates with the user interface manager using TCP/IP protocol.Processor-implemented monitor and control modules gather operating data from the rectifier units, battery connection units and power distribution units. From these data, statistical operating data are calculated and stored in a database managed by the resident processor within the power system control unit. The system expansion analysis module analyzes the statistical data in view of a set of predetermined warning and alarm threshold parameters, which may be factory specified or user settable. If an alarm or upgrade condition is detected, the system expansion analysis module generates an upgrade notification that is optionally sent in a variety of forms including local audible or on screen notification, remote alarm through network connection to a remote computer, via internet web browser and e-mail message. The system can also optionally initiate automated order processing to place orders for upgrade or expansion equipment and installation services.

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BROWSER-ENABLED REMOTE USER INTERFACE AND AUTOMATED EXPANSION ANALYZER FOR TELECOMMUNICATIONS POWER SYSTEMS

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates generally to power systems for telecommunications equipment and networks. More particularly, the invention relates to a distributed user interface technology to simplify the operation and control of power supply systems for telecommunications and networking applications; the invention additionally relates to an automated system for analyzing the operating status of a power system and for assessing when modules within the power system need to be upgraded. In one embodiment the automated system initiates an electronic commerce transaction to place the order for the upgrade equipment.

The power system of a typical telephone central switching station or Internet routing station is a complex, modular system employing one or more rectifier subsystems and one or more power distribution subsystems connected through a common bus. Also, many power supply systems today have a controller that coordinates the operation of the rectifier and distribution subsystems. Frequently telecommunications systems require backup power, which is typically supplied through a large bank of storage batteries.

Interacting with this complex assemblage of components has heretofore required a fairly high level of technical skill. Skilled engineers are expensive. When it is necessary to make adjustments to the power supply system, or to monitor operating parameters and make appropriate configuration adjustments, traditionally the engineer or technician must visit the site where the power supply system is located so that the operating conditions may be observed and appropriate action taken. While some large installations may have engineers or technicians on staff, many smaller installations, particularly those located in rural areas, are normally unmanned. While it is possible to schedule routine maintenance visits to such remote sites, power supply systems for telecommunications equipment are also regularly subjected to electrical storms and other natural phenomena that create power outages on the electrical power grid to which the power supplies are connected. When AC power is lost due to a power outage, the power supply system will usually switch to reserve power, supplied by batteries or diesel-powered AC generators, or the like. Although the switchover to reserve power is automatic, the available reserve power is not endless. At some point, an engineer or technician may need to make a command decision as to which circuits will continue to

be powered and which will be temporarily shut off. In the past, this would be done by making a personal visit to the site.

Electrical storms and other natural phenomena can sometimes create power outages over a widespread region. When such outages occur, it may become necessary for engineers and technicians to visit numerous sites, all within the time that reserve power is being maintained. When a large number of sites are without AC power due to an outage, engineers and technicians must work very efficiently. At such times, an easy to use, consistent user interface is a highly valuable asset.

There are, of course, numerous other situations in which an easy to use, consistent interface is desirable. For example, as the telecommunications system grows, additional loads may be added to the system, necessitating power supply system upgrades. In modular power supply systems, additional rectifier subsystems can be plugged in to increase the power delivery capacity. This may necessitate adding additional backup batteries, as well. When engineers or technicians make such upgrades, they need a clear, easy to use interface through which they will set the operating parameters of the newly added equipment. If any real-time values, reflecting operating currents, voltages, temperatures and the like, are not within expected ranges, the engineer needs to be able to quickly identify the cause.

The present invention provides a remote user interface system that will allow a remote browser application to monitor and control the power system from anywhere in the world. The interface system further supports a local user interface, such as in the form of a liquid crystal display screen and touchpad interface, to provide the same information that is available through the remote browser. Preferably the local interface and the remote browser interface are configured as a series of menu screens providing both static and dynamic (real-time) information. Preferably the screens of the remote browser interface and the local interface are of the same or similar layout so that the user of the remote browser interface will be familiar with the local interface, and vice versa.

The remote user interface system employs a monitor and control system that is coupled to the electric power supply system for obtaining operating state information from at least one of the subsystems of the power supply. The monitor and control system also provides operating state information to at least one of the subsystems of the power supply. A data storage system associated with the monitor and control system stores the state information. A user interface manager is coupled for accessing the data storage system. In the preferred embodiment the user interface manager can both read

from and write to the data storage system, thereby datalogically linking the user interface manager with the power supply subsystems.

The user interface manager is operative to deliver an executable Java applet to the remote browser application. The applet generates a user interface within the browser application for monitoring and controlling the electric power supply system. In the preferred embodiment the user interface manager is configured to supply selected state information to the applet for display by the remote browser within the remote user interface. The user interface manager is further configured to receive data values generated by the applet in response to user interaction through the user interface. It communicates these data values to the data storage system for use in controlling the electric power supply system.

Further in accordance with the invention, the remote user interface system generates a plurality of linked pages containing both static text and/or graphical information and also dynamic (real-time) information. The real-time information reflects actual operating conditions within the power supply system, such as voltages, currents, temperatures, time intervals, and the like. This dynamically-displayed content also represents active regions with which the user may interact. For example, the user can select an active region, such as a voltage, by manipulating the user interface cursor until it points to that region. Then, by selecting or clicking on the region, a subsequent page is automatically displayed, showing additional static and/or dynamic information that has a potential bearing on the real-time data previously displayed. Thus, if the user wishes to ascertain why a particular operating voltage is too high, he or she simply clicks on the displayed voltage value and a subsequent screen is displayed, showing control settings and other parameters that have an effect on that operating voltage. Thus the user interface is quite intuitive and easy to use.

Of further concern, telecommunications systems use comparatively sophisticated, modular power systems that provide power even during AC power outages. The power system and its associated reserve power subsystems (e.g., storage batteries, diesel-powered generators, etc.) represent a sizable financial investment. In addition to the costs of the equipment itself, the administrative costs to operate the equipment are quite substantial. Aside from the day-to-day operations needed to run the telecommunications system and its power system, there is the additional administrative burden of monitoring when the power system needs to be repaired or upgraded. Due to the complexity of these systems, these maintenance and upgrade activities are not as simple as they might first appear.

A power system is usually engineered and configured when the system is first installed. The design engineer estimates how much load will be required, what duration is needed for the reserve power systems, and so forth, and designs the power system accordingly. However, a telecommunications system is not a static entity. New pieces of equipment may be added from time to time to support new customers. The engineering departments responsible for adding new equipment to support new users may not necessarily have responsibility for monitoring and upgrading the power system. An engineer installing a new switch or router, for example, might simply consider the power system to be adequate, based on current power usage, and may therefore not ascertain that under different load conditions the power system may need to be upgraded.

In an effort to make these power systems easier to use and maintain, the invention provides an automated expansion analyzer that monitors each of the components of the power system and automatically assesses when expansion or upgrade is called for. In power systems made up of modular units, the invention analyzes each modular unit and determines when additional modular units should be procured. The system supports both local and remote display of upgrade notification messages, and is further capable of providing notification by e-mail message. In one embodiment the system will further initiate electronic commerce transactions to place the required upgrade modules on order so that they will be automatically shipped to the site for installation.

In accordance with one aspect of the invention, the automated expansion analyzer includes a monitor system that is coupled to the power system for obtaining operating state information from at least one of the power system's subsystems. In the preferred implementation, these subsystems comprise modular units, such units include rectifier units, battery connection units and power distribution units. The monitor system also obtains information about the reserve power batteries coupled to the battery connection unit or units. A system expansion analysis module communicates with the monitor system. The analysis module has a data store that contains at least one alarm threshold parameter. The system expansion analysis module employs a processor for assessing the operating state information vis-a-vis the alarm threshold parameter or parameters. The system further includes a user interface module that communicates with the analysis module to provide upgrade notification with respect to a selected one of the subsystems, before the capacity of that subsystem is reached.

The automated expansion analyzer can significantly reduce the cost of ownership by greatly simplifying the system monitoring and upgrading functions. When the system senses that the overall load is approaching a predetermined threshold parameter, additional rectifier units may be required. The system will notify the owner and, if desired, automatically place an order for the requisite number of rectifier units. As loads increase, the analyzer can also determine that additional battery strings need to be ordered, in order to provide the backup power duration specified during the initial system design. The need for additional battery connection units may also be assessed and ordered. Similarly, when the system detects that the power distribution unit or units are reaching capacity an additional power distribution unit may be indicated and placed on order. Such condition could occur, for example, when a predetermined number of load connections (circuit breaker-protected) have been made, or when the maximum capacity of the distribution unit has been reached.

The analyzer is flexible enough to include multiple sets of threshold parameters so that the user can define a set of warning threshold parameters to send alert messages before the over-capacity thresholds have been reached. This gives the system operator a great deal of flexibility in customizing the upgrade plan to match the company's business structure.

For a more complete understanding of the invention, its objects and advantages, refer to the following specification and to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a front view of an exemplary electric power supply system, illustrating how the modular subsystems may be configured;

Figure 2 is a software layer diagram illustrating the software environment in which the presently preferred remote user interface system may be implemented;

Figure 3 is data flow diagram illustrating a presently preferred embodiment of the user interface system;

Figure 4 is a block diagram illustrating the inter-module interface whereby components of the remote user interface system communicate with one another;

Figure 5 is a set of user interface diagrams, illustrating how active and static regions are linked in the presently preferred remote user interface system and

Figure 6 is a data structure diagram illustrating the messaging technique employed by the remote user interface applet when communicating with the remote access module of a local master control unit.

Figure 7 is a block diagram of an exemplary telecommunications power system;

Figure 8 is a block electronic circuit diagram illustrating how the modular units of a typical power system are configured;

Figure 9 is a data flow diagram illustrating how the upgrade notification system is implemented in software;

Figure 10 is a block diagram illustrating how the system expansion analysis is performed in the preferred embodiment;

Figure 11 is a block diagram illustrating more specifically how the rectifier capacity alarm is calculated in the preferred embodiment;

Figure 12 is a block diagram illustrating more specifically how the battery connection unit capacity alarm is calculated in the preferred embodiment;

Figure 13 is a block diagram illustrating more specifically how the distribution unit capacity alarm is calculated in the preferred embodiment.

Figure 14 is a block diagram illustrating more specifically how the reserve battery capacity alarm is calculated in the preferred embodiment;

Figure 15 is a block diagram illustrating further details of the e-commerce capabilities of the upgrade analyzer.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An exemplary power supply system is illustrated at 10 in Figure 1. The system of the illustrated embodiment employs a rackmount unit having mounting rails 12 that supports a common bus structure that includes a data bus 14 and a DC power bus 15 to which a plurality of individual power supply system components are attached. Illustrated in Figure 1 is a modular battery connection unit 16 connected through suitable heavy duty cables 18 to a battery supply 20. A modular power distribution unit 22 houses a plurality of individual circuit breakers 24, which supply operating power to the telecommunications equipment 26. The system also includes a modular master control unit 28 and a plurality of modular rectifier units 30 (four rectifier units are illustrated in Figure 1).

The master control unit 28 has a local user interface, preferably in the form of a display panel 30, such as an LCD panel and a touchpad pointing device 32. The user interacts with the local user interface by manipulating the touchpad 32 to, in turn, manipulate the cursor 34 displayed on panel 30. By tapping the touchpad or pressing the left and right selector buttons 36, the user can select various menu screens to control the power supply system as will be more fully described below.

The master control unit is coupled through a suitable interface to a computer network such as the Internet. In Figure 1 the network has been generically illustrated at

36 and the master control unit is shown connected through a telephone interface jack 38 to the telecommunications unit 26. While a telephone connection has been illustrated here, it will be appreciated that the master control unit could be connected to network 36 by other types of connections.

In accordance with one aspect of the invention a remote user interface is provided through a suitable computer or workstation such as computer 40. Computer 40 is attached to network 36 so that it may communicate with the master control unit 28 through the network connection provided. Computer 40 hosts a browser application, such as a web browser application, which in turn runs a remote-user interface applet. The applet provides connectivity with the master control unit 28 and allows the user to fully interact with the control unit through the remote browser interface.

In the presently preferred embodiment, the power supply units illustrated in Figure 1 are designed for modular interconnectivity. Each of the modular units includes supporting hardware and software for communicating over data bus 14. While the modular units are capable of peer-to-peer communication, the presently preferred embodiment places the primary control functions within the master control unit 28. The reserve power unit 16, power distribution unit 22 and rectifier units 30 are provided with processors, referred to as "neurons," that handle the monitoring, control and communications functions associated with these modules. The master control unit includes a more powerful processor that runs the controller software that coordinates operation of the other modules as well as providing the user interface functionality.

The presently preferred embodiment employs a networked connection between the processor of the master control unit and the neurons of the other modules that make up the system. Communication is effected over bus 14 using the CAN bus protocol. The master control unit and each of the neurons associated with the other modules contain the necessary hardware and driver software for communicating over the CAN bus. Although other protocols may be used, the CAN bus protocol is presently preferred because it is relatively robust in the presence of electrical noise such as would be expected in a power system.

To better understand how the remote user interface works, an overview of the presently preferred software architecture for the master controller will be presented. Referring to Figure 2, the software architecture may be defined in terms of three interacting layers: low level layer 100, real-time layer 102 and user interface layer 104. Although other operating systems may be used, the presently preferred embodiment uses the QNX operating system which provides a real-time multitasking environment.

The low level layer 100 consists of the low level drivers for communication and hardware interface, such as modem, Ethernet, RS-232, CAN, LCD display, pointing device, I/O interface, flash memory, watchdog and trace/log. Layer 100 provides services to the real-time layer 102 through an application programming interface (API). In this way, applications running in the real-time layer may be decoupled from hardware platform dependence.

Real-time layer 102 provides monitor and control functions for each of the reserve power module, power distribution module and rectifier modules as well as plant voltage and current monitoring and control functions applicable to the entire power supply system. In addition, alarm condition monitoring and diagnostic functions and software upgrade functions are provided in real-time layer 102.

User interface layer 104 provides the functionality for supporting both local and remote user interface control of the modules in the real-time layer 102. The preferred embodiment implements remote access through a web-based user interface through either an Ethernet or modem connection using TCP/IP and modem drivers found in layer 100.

The user interface layer and the real-time layer communicate through access to a shared database 107 that is administered by database manager 106. Figure 4 illustrates how the various modules within layers 102 and 104 communicate via the database manager 106. The database manager implements a "soft" data bus 108 which provides a communication backbone within the controller software. The soft data bus enables module plugability, making it easy to add additional modules when upgrading or enhancing the controller software. Modules connected to the database manager (and thereby connected to the soft data bus 108) interact with each other by reading from and writing to the database 107 being administered by database manager 106.

Thus if the user wishes to access an alarm diagnostic value, for example, the user would interact through the user interface manager 110 (a component within layer 104) to read the alarm diagnostic values obtained from the database 107 by database manager 106. The alarm diagnostic module 112 operating in conjunction with alarm input/output module 114 (a component within layer 102) is responsible for writing values to database 107 that are accessed by the user interface manager when interrogating the alarm diagnostic conditions.

By way of further example, if the user wishes to ascertain the current power plant voltage, the user interface manager 110 is again used. This time the user interface manager will request database manager 106 to obtain values stored in database 107

that have been written to the database by the plant voltage/current monitor and control module 116. Similar connectivity is provided between the user interface manager and software upgrade module 118, power distribution monitor and control module 120, reserve power monitor and control module 122, rectifier monitor and control module 124 and neuron manager 126.

Figure 3 provides a different view of how the modules within the presently preferred software architecture interact with one another to provide the remote user interface functionality. Figure 3 is a dataflow diagram in which communication between modules is illustrated using interconnecting lines with double-headed arrows and in which associations or relationships between modules and/or components are shown by lines without arrows. Database manager 106 and its associated database 107 are illustrated in the center of the diagram. The user interface manager 110 and the various monitor and control modules 116, 120, 122 and 124 communicate with the database manager. The rectifier monitor and control module 124, in turn, communicates with the rectifier unit 30; reserve monitor and control module 122 communicates with the reserve power unit 116; and distribution and control module 120 communicates with the distribution unit 22. AC power is supplied from the AC mains to the rectifier unit(s) 30, which in turn supply DC power over the DC power bus to both the reserve power unit 16 and the distribution unit 22. Thus energy from the rectifier units is supplied to both power any loads attached to the distribution unit through breakers 24 and also to maintain the reserve power batteries at full charge. In the event the AC mains are lost, due to a power outage, the reserve power unit 16 supplies DC power via the DC power bus 15 to the distribution unit 22 so that the loads will continue to operate uninterrupted.

The user interface manager 110 supports both local and remote interface functionality. Local interface functionality is provided through a local graphical user interface (GUI) module 150 while remote user interface functionality is provided through a remote access module 152. The remote access module will support multiple communication sessions concurrently. For each communication session a graphical user interface (GUI) daemon 154 is instantiated. The presently preferred remote user interface is designed to work using the TCP/IP protocol employed by the Internet. The GUI daemon 154 processes TCP/IP packets, packaging information sent by remote access module 152 over the network 36 and unpackaging packets sent to the remote access module from the network 36.

The local GUI module 150 is designed to receive user input through a touchpad 32 having pushbuttons 36 to simulate the right and left mouseclick buttons of a computer

graphical user interface. The local GUI 50 also works with display panel 30 on which a graphical cursor 36 is displayed. The user can make menu selections by manipulating the cursor using touchpad 32. In the illustrated embodiment menus are accessible through a button 160 in the lower left-hand corner of the screen. The user can also select navigation buttons 162 that simulate the Home, Back and Forward buttons commonly found on web browsers. The user can also select displayed text that appears in the center portion of the display screen as at 164. The displayed text can either be static text that does not change during system operation or dynamic text that does change during system operation. Typically the dynamic text is tied to real-time values measured by one of the monitor and control modules (e.g. modules 116 120, 122 and 124) or from the alarm and diagnostic modules (e.g. modules 112 and 114).

Clicking on or selecting a dynamically displayed value, such as the float voltage value, for example, causes the user interface manager to display a different screen that is relevant to the float voltage value. Thus, clicking on the numeric value "-54.5" in the illustrated local display 30 would cause a new screen to be displayed showing other measured values and parameters that affect the float voltage. The user could then make changes to these settings by selecting new settings from a pull-down menu box or other graphical user interface input technique. The new setting would then be communicated through the user interface manager to the database manager 106 for entry into database 107. The monitor and control module or modules that use this setting would then access the database to obtain the new setting and make adjustments to the appropriate modules as needed to effect the new setting. This could in turn cause changes in measured values (e.g., float voltage) which would be communicated by the respective monitor and control modules to the database manager for writing into the database 107.

An exemplary set of user interface screens has been illustrated in Figure 5. From the main graphical user interface screen 200, the user can navigate to a variety of different screens. Five subscreens are illustrated in Figure 5. Clicking on the dynamically displayed value for temperature compensation takes the user to screen 202 where various voltage thresholds can be set. Clicking on the dynamically displayed load current value takes the user to the distribution module status list screen 204. Clicking on the dynamically displayed rectifier current value takes the user to screen 206, which shows the rectifier status list. Clicking on the dynamically displayed battery current takes the user to screen 208, which shows the battery connection module status list. Clicking on static text regions such as the text reading "Load Current", "Rectifier Current" or "Battery Current" takes the user to the Current Thresholds screen 210. In this screen the user

can change current threshold settings by selecting radio buttons or by entering values in the text boxes illustrated. If desired, the local GUI module 150 (Fig. 3) can support a keypad entry device for entering numbers into the value fields such as those shown in screens 202 and 210 of Figure 5. Alternatively, a pop-up keypad applet can be displayed on the user interface screen, allowing the user to enter numbers by clicking on digits in the displayed keypad.

The remote user interface of the preferred embodiment is designed to simulate the functionality and appearance of the local graphical user interface. This is accomplished through a remote user interface applet. The remote user interface applet is a stored application program that may be stored in the master control unit 28 for distribution as needed. The applet may be stored in non-volatile memory within the controller, which may be optionally associated with the database manager 106 and database 107. The remote user interface applet is shown in dashed lines at 220 in Figure 3 to illustrate that the applet may be stored in database 107 or within some other memory device such as a read only memory ROM, flash memory or the like. Such memory is illustrated diagrammatically at 222 in Figure 3.

The remote user interface applet is downloaded by the user interface manager through the remote access module 152 to the workstation or computer 40. Computer 40 may run a standard web browser and may be suitably connected to network 36 to support TCP/IP communication. If the connection to network 36 is by modem, additional PPP protocols may be used to establish the Internet connection. Once the remote applet is downloaded to computer 40 it runs in the memory of computer 40 as illustrated diagrammatically at 224.

The remote user interface applet provides several functions. First, it generates the static display screens (text and graphics) to mimic the appearance of the screens on the local user interface. Of course, because computer 40 will typically have a larger display area than the local display, the remotely displayed user interface can have additional displayed content as well. The remote user interface applet is also involved in displaying dynamically generated information and for sending control information back to the master control unit. When the user wishes to read a value within the power supply system, or wishes to change a setting or value, used by the power supply system, the user interacts with the remote user interface screen. The applet, in turn, constructs a message that identifies not only the parameter or setting entered by the user, but also the screen descriptor and field identifier so that the context of the user's entry may be fully defined. The remote user interface applet then packages this message in a TCP/IP

packet or series of packets and sends it through the network to the remote access module 152.

Once received by the remote access module the associated GUI daemon 154 unpacks the TCP/IP message, extracts the enclosed message sent by the remote user interface applet and passes this information to the user interface manager. The user interface manager then interprets the message by parsing it into its constituent parts. At this point, the user interface manager uses the constituent part information the same way as it would use information from the local GUI module 150.

Figure 6 diagrammatically illustrates how the remote user interface applet may package a request for information, such as a request for a particular voltage value stored in database 107. The remote user interface applet generates screen 300, which may have a screen identifier I.D. value of SCR 47. The requested voltage value may be physically located in a dynamically changing field 302 at (X,Y) position (10, 5). The remote user interface applet would thus construct message 304 to embed the screen identifier, the X and Y position values, and optionally a setting or value to be communicated to the master control unit 28. In this case, the particular message being sent is a request for information from the database. Thus a suitable request information code may be embedded in message 304.

The remote user interface applet then packages message 304 within a TCP/IP packet 306 and the packet is sent over the Internet or other suitable connection to the remote access module 152 within the master control unit (Fig. 3). The GUI daemon 154 associated with the remote access module unpacks the message 304 and the user interface manager then parses the message to determine that the user is on screen 47 at X,Y location (10, 5). Because the message is a request for information, the user interface manager passes the request to database manager 106 for a database lookup operation. The database manager obtains the current value of the requested information and passes it back to the user interface manager, which in turn passes the value to the remote access module 152. The remote access module then, using the services of GUI daemon 154, constructs a reply message 308 that contains the screen I.D., the X and Y values and the requested value obtained by database lookup. In the example illustrated in Figure 6, the requested information is a voltage: 54.4V.

The remote access module bundles message 308 within a TCP/IP packet or packets 310 and the packet is sent back to the remote user interface applet 224 so that the value may be displayed in field 302 of the display screen 300. In this way, the remote user interface applet is able to obtain values reflecting current operating

conditions from the master control unit. The applet can also send operating parameters, such as those input by the user through a suitable dialogue box, pull-down menu, radio button or the like. To send control values to the master control unit the remote user interface applet constructs a message similar to that shown at 304, except that the command would be an instruction to write a value to the database and would provide the appropriate value as supplied by the user. The remote access module would then unpack the message at the master control unit and place that value in the database for use by the other modules.

Referring now to Figure 7, an exemplary telecommunications power system is illustrated generally at 1010 in Figure 7. The system consists of a rack mount chassis 1012 into which a plurality of individual modular units are installed. The modular units share a common data bus 1014, which may be attached to one of the rails of the rack mount unit. In a presently preferred embodiment, the data bus is designed to carry data signals using the CAN bus protocol. Although other protocols may be used, the CAN bus protocol is presently preferred because it is relatively robust in the presence of electrical noise such as would be expected in a power system.

An exemplary piece of telecommunications equipment is illustrated at 1016. The power system supplies DC power to equipment 1016 through one or more circuit breakers 1018 that are installed in a modular distribution unit 1020. The power system is designed to supply power even during AC power outages. A battery connection unit 1022 serves this function. The battery connection unit 1022 is connected through heavy duty cable 1024 to a suitable reserve power source, such as a rack of rechargeable batteries 1026. During power outages, DC power is supplied through cable 1024 to the battery connection unit 1022 to, in turn, supply power to the telecommunications equipment 1016. During normal operation, when AC power is present, the rechargeable batteries 1026 are charged by supplying charging current through cable 1024.

The power system also includes one or more rectifier units 1028 (two are illustrated in Figure 7). These rectifier units are connected to receive alternating current from the AC power mains and rectify that current into suitable DC current at a voltage controlled by the rectifier unit. Typically, each rectifier units supplies DC current at a voltage that will properly power the telecommunications equipment 1016 and also maintain the batteries 1026 at a proper float voltage for charging. In this regard, storage battery subsystems in a typical telecommunications installation represent a significant part of the costs of the system. Thus, it is desirable to maintain the batteries at the proper manufacturer-dictated voltage during charging.

To coordinate the operation of the above-described modular units, a master control unit 1030 is provided. The master control unit handles many of the power system control and monitoring functions and is instrumental in gathering and assimilating the data needed to implement the automated upgrade analyzer system. The master control unit communicates with each of the other modules via bus 1014, as will be more fully described below. The master control unit is also coupled through a suitable network interface 1032 to a telecommunications network or computer network such as the internet. In Figure 7 these networks are collectively depicted at 1034. Because the power system is typically in close proximity to telecommunications equipment 1016, in some implementations, the network interface 1032 may be directly connected to the telecommunications equipment 1016, as illustrated by solid line in Figure 7. Of course, other connections to network 1032 are also possible as depicted diagrammatically by a dashed line.

The connection of master control unit 1030 to network 1034 places the master control unit in potential communication with other computers attached to the network. These can include computers attached locally, such as computer 1040 that comprises part of the local area network or wide area network of the telecommunications installation. Such computers can also include remotely attached computers such as computer 1042 and its associated work station 1044. As will be more fully explained, the automated upgrade analyzer system is capable of communicating via network 1034 in a variety of sophisticated ways, to send alarm messages and upgrade notifications to the proper authorities when units within the power system need to be upgraded or replaced. These communications can also effect electronic commerce transactions to place orders, initiate shipment and installation orders, effect electronic funds transfer for payment and make appropriate entries in accounting and system configuration records, all based on information gathered and analyzed at the local power system.

Figure 8 shows in greater detail how the modular units of the power system are connected both to communicate over bus 1014 and also to share a common DC bus 1050. AC power is supplied from the AC mains 1052 to the rectifier unit 1028. The rectifier unit converts the AC current into DC current and establishes the voltage at a predetermined voltage based on control instructions stored within a microprocessor unit 1054, referred to as a "neuron." The neuron is a microprocessor having onboard nonvolatile memory for storing local data values used to establish the output voltage of the rectifier. The neuron also stores values indicative of measured voltages and currents within the rectifier unit. These values are periodically supplied to the master

control unit over bus 1014. Specifically, the rectifier includes a shunt circuit 1056 that measures the current flowing between the rectifier unit and DC bus 1050. Another sensor 1058 measures the rectifier output voltage. Both current and voltage measurements are supplied to neuron 1054 for storage in local nonvolatile memory.

The battery connection unit 1022 is similarly configured. It includes a neuron processor 1054 and also suitable shunt and voltage sensors for measuring the current flowing between the power distribution unit and DC bus 1050 as well as the voltage at the output. The reserve power unit is further coupled to rechargeable batteries 1026 so that the batteries may be charged during normal operation and may be used to supply current to DC bus 1050 when the AC mains are off-line. In addition, the reserve power unit includes a contactor, such as a solenoid-operated contactor, that will break connection to DC bus 1050 when signaled to do so by neuron 1054.

The distribution unit 1020 is configured in a similar fashion to include neuron 1054 as well as shunt sensor 1056 and voltage sensor 1058. The power distribution unit may optionally include additional shunt sensors to measure the current flowing through each individual circuit breaker that supplies current to the telecommunications system load. Thus, the neuron 1054 of power distribution unit 1020 stores voltage and current information indicative of the total current being supplied to the telecommunications system load, and optionally how much current is being supplied through each of the individual breakers.

Master control unit 1030 lies at the heart of the system. It provides most of the system-level monitor and control functions for the power system. Master control unit 1030 is connected to DC bus 1050 and also to data bus 1014 as the other modules are connected. It includes a more powerful processor 1060 that communicates with the neurons of the other modules, supplying individual data values to those modules and collecting individual voltage and current values from those modules.

The system architecture is configured so that the individual modules operate independently of one another and without requiring constant communication with processor 1060 of the master control unit 1030. Thus, the rectifier module, for example, can be provided with default operating parameters and it will perform its rectifying function using those default parameters without requiring further instruction from the master control unit. The default values can be changed by the master control unit through communication between processor 1060 and neuron 1054 over data bus 1014.

Figure 9 shows the pertinent software components implemented by processor 1060 to manage the system expansion analysis and upgrade notification functions. Like

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the neurons, the processor of the master control unit stores values indicative of operating conditions and control parameters. However, unlike the neurons, which store only local values, the processor 1060 of the master control unit stores collective values obtained from all of the other units, as well as additional values that are input by the system operator during system configuration or that are calculated by processor 1060 in performing the monitor and control functions.

In the presently preferred embodiment, processor 1060 maintains a database 1100 that is administered by a database manager module 1102. Other software modules communicate with database manager module 1102, establishing database manager module 1102 as the communication pipeline between other software modules. For example, in Figure 9, the control and monitor modules 1104 are illustrated as communicating with database manager module 1102. User interface manager module 1106 also communicates with database manager 1102. Thus, if the user interface manager module 1106 needs to communicate with one of the control and monitor modules 1104, it will do so by passing information to the database manager 1102. The database manager, in turn, stores the passed information as data values in database 1100. The recipient module then reads those values from database 1100 using the services of database manager 1102.

In the presently preferred embodiment, the system software employs or instantiates a control and monitor module 1104 for each of the hardware units plugged into the power system. Thus, in a typical system there would be a control and monitor module associated with reserve power unit 1022, another control and monitor module assigned to distribution module 1020, and one or more additional control and monitor modules assigned to rectifier units 1028. Each of these control and monitor modules is responsible for collecting operating current and voltage information from their respective units and communicating that information to database manager 1102 for storage in database 1100. Each control and monitor modules is also responsible for changing any of the default settings within its assigned unit. Thus, if the rectifier voltage needs to be raised from 54.2 to 54.4 volts, the control and monitor module associated with the rectifier unit would obtain the new voltage setting from database 1100 (via database manager 1102) and send that value to the neuron of the associated rectifier for placement into the local nonvolatile storage of the rectifier. The rectifier would then respond by raising its voltage accordingly.

The user interface manager module 1106 is responsible for supplying information to the user through either a local display screen associated with the master control unit

or through a remote computer attached to network 1034. In the presently preferred embodiment, the user interface manager delivers a Java applet through network 1034 to an attached computer. The applet then runs within a standard internet browser and allows the user to interact with the power system in the same way as a user would interact if operating through the local display screen.

The presently preferred embodiment maintains a history log within database 1100 that documents when certain events have occurred, such as over current conditions, AC power outage conditions, voltage and current spikes, and the like. The system utilizes a log/trace module 1108 to gather and process the historical event information. Module 1108 communicates with database manager 1102 to store these data within a history log file within database 1100. The history log data are useful, for example, when analyzing a system to determine when and why certain abnormal events have occurred, as a means of diagnosing system problems.

The data collected by log/trace module 1108 are used by alarm module 1110 to assess when certain operating conditions are at levels that warrant the operator's attention. Alarm module 1110 communicates through database manager 1102 with database 1100. It periodically examines the values in database 1100, including values obtained by the control and monitoring modules 1104 and by the log/trace module 1108. Alarm module 1110 analyzes the stored values to determine when system expansion is warranted.

Figure 10 shows the presently preferred system expansion analysis process performed by the alarm module 1110. The analysis assesses rectifier capacity, reserve battery system capacity, distribution capacity and reserve connection capacity. Rectifier capacity involves the basic question of whether there are a sufficient number of rectifier modules, of sufficient size, to handle the telecommunications system load and the battery recharge requirements. Storage capacity involves the basic issue of whether sufficient storage battery capacity is available to maintain the telecommunications system in operation for a predetermined time. Distribution capacity involves the issue of whether the distribution unit has adequate head room to supply the maximum plant load and whether there is an adequate number of circuit breakers.

When the power system is initially configured, the engineer selects the proper number of rectifier units, the proper number of battery strings and battery connection units, and the appropriate number of distribution units and circuit breakers to handle the anticipated system load with an appropriate reserve power backup time. However, as

additional loads are added to the system over time, the originally designed system may no longer be adequate. This is where the system expansion analysis comes into play.

Alarm module 1110 performs statistical analysis of the values stored in database 1100. The values stored in database 1100 represent both the most recently measured voltage and current readings from the other modules and also the event data stored in the history log file. The alarm module 1110 examines these data to generate statistics that are then used to assess rectifier capacity, storage capacity and distribution capacity.

Figures 10 and 11-14 illustrate how the statistical analysis is performed to assess these capacities. Referring to Figure 10, rectifier capacity is assessed by calculation block 1200 using the total plant load, battery recharge time and battery size as inputs. Battery storage capacity is calculated by block 1202 using the total plant load as the input value. Distribution capacity is calculated by block 1204 using the distribution unit load and the number of loads (circuit breakers) used as input values. Reserve connection capacity is assessed by calculation block 1205 using battery current to a given connection unit as the input value.

Figure 11 shows in greater detail the algorithm performed by block 1200 in assessing rectifier capacity. Figure 12 is a similar diagram showing the algorithm used by block 1202 to assess total battery capacity. The algorithm used by block 1204 to calculate distribution capacity is shown in Figure 13 and the algorithm used by block 1205 to assess reserve connection capacity is shown in Figure 12.

Each of the calculation blocks 1200, 1202, 1204 and 1205 can compare the calculated capacity value against two different thresholds, a warning threshold and an alarm threshold. The warning thresholds, illustrated in Figure 10 at 1206, 1208 and 1210 may be set by user preference as depicted at 1212. The alarm thresholds 1214, 1216 and 1218 are normally set to represent a predetermined percentage of the over capacity condition. As illustrated, each of the warning thresholds and each of the alarm thresholds can be individually set for the three different capacity calculations.

When any of the warning or alarm thresholds are reached, the system expansion analysis calculation block 1220 examines the state of all warning and alarm conditions and generates the appropriate output. If the rectifier capacity reaches the warning threshold, for example, the system expansion analysis module will construct the appropriate warning message which is then sent by a variety of different means as discussed below. If the condition that caused the rectifier capacity to exceed the warning threshold also caused the distribution capacity to exceed its warning threshold,

then the system expansion analysis module constructs the appropriate message to notify the user that both conditions need to be attended to.

The presently preferred embodiment generates both local and remote alarms as well as providing e-mail notification of the alarm conditions and even effecting automated order processing as illustrated by outputs 1222. Referring to Figure 9, the local alarm notification (which can be based on either a warning threshold or an alarm threshold) is supplied via user interface manager 1106 to the local display screen as an upgrade notification 1224. A similar upgrade notification message may also be displayed on a remote computer 1044 running suitable browser software. This is accomplished by a remote access module 1109 that communicates with the user interface manager 1106 and also with network 1034. The user interface manager 1106 downloads a Java applet 1240 via network 1034 to the remote computer 1044. The applet runs within the browser application of remote computer 1044. The user interface manager then sends the upgrade notification through the remote access module and via the network to the applet 1240 for display on the browser screen as upgrade notification 1244r.

The presently preferred embodiment uses TCP/IP protocol for communicating messages over network 1034 to the applet 1240. In this regard, the remote access module 1109 is configured to package upgrade notification messages within appropriate TCP/IP headers for transmission over network 1034 to the applet. The applet then unpacks the message by stripping away the TCP/IP headers to display the upgrade notification within the browser screen.

Because the upgrade notification messages may be sent at any time, the remote access mechanism is preferably constructed using push technology. In other words, applet 1240 (or its host web browser) periodically interrogates the remote access module 1109 to determine if there is any new information to report.. If any upgrade notification has been triggered through the system expansion analysis calculation, the remote access module 1109 notifies applet 1240 of this fact and then participates in a series of message exchanges whereby the upgrade notification is downloaded to the applet for display. While push technology is presently preferred, it will be appreciated that the invention could be implemented using pull technology whereby the responsibility to request upgrade notification messages is initiated by the user of the remote computer.

The remote messaging capability whereby remote access module 1109 sends upgrade notifications to a remote computer 1044 can be further exploited to generate more complex forms of messaging and electronic commerce.

Figure 15 illustrates some of these more sophisticated transactions in greater detail. In Figure 15 the local telecommunications site is depicted diagrammatically by block 1300, with the remote access module 1109 being separately shown. Refer to Figure 9 to review how remote access module 1109 integrates with the remaining components of the system.

When an upgrade notification is generated (based on either a warning threshold or an alarm threshold) the remote access module 1109 transmits a TCP/IP packet 1302 over network 134. The packet includes the identity of the local telecommunications site, as well as other pertinent information regarding the upgrade notification. Packet 1302 is sent to an e-commerce host computer 1304, which assembles a collection of information needed for subsequent e-mail messages and e-commerce transactions. In this regard, the database 1100 (Fig. 9) of each master control unit 1030 maintains a complete record of all installed units, including pertinent serial number data and interconnection data. When the upgrade notification message is sent, the e-commerce computer 1304 communicates with the local telecommunications site to request additional information from database 1100, so that it can prepare a detailed report concerning the local telecommunications site. The detailed report may include, for example, a listing of all of the installed components, including pertinent connection information and circuit diagrams, showing which components are connected to each other. The nature of the upgrade notification message is then assessed in context of this additional information, and a detailed electronic report is generated by the e-commerce computer 1304. The e-commerce computer may then send one or more e-mail messages 1306 over network 1034. The messages may include all or portions of the detailed report to one or more e-mail recipients, as appropriate. Thus, the telecommunications business office can be notified that an upgrade will need to be scheduled, while the engineering department may be notified of particular engineering details concerning the recommended upgrade.

If desired, e-commerce computer 1304 can also communicate directly with a business system computer 1308 that is also connected to network 1034. The business system computer 1308 may be, for example, connected with the business system and accounting system computers employed by the telecommunications operation. The business system responds to the message received from computer 1304 by generating appropriate purchase orders 1310 for use in ordering the recommended upgrade equipment.

If desired, the entire order processing function can be automated further. In such case, the e-commerce computer 1304 sends a message through network 134 to the host computer 1312 of the manufacturer or supplier of upgrade parts and installation services. Thus, the local telecommunications site can be furnished with upgrade parts and services automatically in response to an upgrade notification message.

From the foregoing it will be appreciated that the user interface of the invention provides a powerful graphical user interface for convenient control of a power supply system by both a local operator and a remote operator through a suitable web browser. Because the remote user interface and the local user interface offer the same functionality, knowledge obtained at either a local facility or a remote facility is easily transferred to the other facility. Thus an engineer working at a local power supply site would readily be able to interact with the system through a remote web browser connection without having to learn a new user interface. By being able to interrogate a number of different facilities from a single web browser at a remote location, one engineer can now do the job of many. This can significantly lower the cost to operate a power supply system within a telecommunications operation.

From the foregoing it will also be appreciated that the automated upgrade analyzer of the present invention has the potential to greatly simplify the management and maintenance of power systems for telecommunications equipment. Because the system expansion analysis and upgrade notification tasks are fully automated, telecommunications companies no longer need to devote expensive engineering resources to these tasks. Much of the routine system expansion and upgrade processing can be handled by business offices, with far less need to rely on periodic local visits by engineers or technicians.

While the invention has been described in its presently preferred form, it will be understood that the invention is capable of modification without departing from the spirit of the invention as set forth in the appended claims.

CLAIMS

What is claimed is:

1. A remote user interface system to enable a remote browser application to monitor and control a power system of the type having one or more rectifier subsystems, one or more reserve power subsystems and one or more power distribution subsystems, comprising:

a monitor and control system coupled to said power system for obtaining operating state information from at least one of said subsystems and for providing operating state information to at least one of said subsystems;

a data storage system associated with said monitor and control system for storing said state information; and

a user interface manager capable of accessing said data storage system and being operative to:

(a) provide an executable applet to said remote browser application, the applet generating a user interface within said browser application for monitoring and controlling said electric power supply system;

(b) supply selected state information to said applet for display by said remote browser within said user interface; and

(c) receive data values generated by said applet in response to user interaction via said user interface and to communicate said data values to said data storage system for use in controlling said electric power system.

2. The remote user interface system of claim 1 wherein said user interface manager communicates with said applet using data packets compatible with the internet protocol.

3. The remote user interface system of claim 1 wherein said user interface manager also supports a local user interface associated with said monitor and control system.

4. The remote user interface system of claim 1 wherein said user interface manager also supports a local user interface that includes a touchpad input mechanism for user interaction with the power system.

5. The remote user interface system of claim 1 further wherein said user interface manager generates at least one display screen containing both static and dynamic content.

6. The remote user interface system of claim 5 wherein said dynamic content represents said state information.

7. The remote user interface system of claim 1 wherein said user interface manager generates at a plurality of display screens, at least a portion of which contain dynamic

content representing said state information, and wherein at least one of said applet and said user interface manager generates hyperlinks connecting said dynamic content with other display screens.

8. The remote user interface system of claim 1 wherein said monitor and control system includes a rectifier monitor and control module for obtaining operating state information from at least one of said rectifier subsystems.

9. The remote user interface system of claim 1 wherein said monitor and control system includes a reserve monitor and control module for obtaining operating state information from batteries attached to said power system.

10. The remote user interface system of claim 1 wherein said monitor and control system includes a distribution monitor and control module for obtaining operating state information from said power distribution subsystem.

11. The remote user interface system of claim 1 wherein said remote browser application is an internet web browser application.

12. A remote user interface system to enable a remote browser application to monitor and control a power system, comprising:

a monitor and control system coupled to said power system for obtaining operating state information about said power supply system and for providing operating state information to said power system;

a data storage system associated with said monitor and control system for storing said state information; and

a user interface manager capable of accessing said data storage system and being operative to provide an executable applet to said remote browser application, the applet generating a user interface within said browser application for monitoring and controlling said power system.

13. The remote user interface system of claim 12 wherein said user interface manager communicates with said applet using data packets compatible with the internet protocol.

14. The remote user interface system of claim 12 wherein said user interface manager also supports a local user interface associated with said monitor and control system.

15. The remote user interface system of claim 12 wherein said user interface manager also supports a local user interface that includes a touchpad input mechanism for user interaction with the power system.

16. The remote user interface system of claim 12 further wherein said user interface manager generates at least one display screen containing both static and dynamic content.

17. The remote user interface system of claim 16 wherein said dynamic content represents said state information.

18. The remote user interface system of claim 12 wherein said user interface manager generates at a plurality of display screens, at least a portion of which contain dynamic content representing said state information, and wherein at least one of said user interface manager and said applet generates hyperlinks connecting said dynamic content with other display screens.

19. The remote user interface system of claim 12 wherein said monitor and control system includes a rectifier monitor and control module for obtaining operating state information from at least one of said rectifier subsystems.

20. The remote user interface system of claim 12 wherein said monitor and control system includes a reserve monitor and control module for obtaining operating state information from batteries attached to said power system.

21. The remote user interface system of claim 12 wherein said monitor and control system includes a distribution monitor and control module for obtaining operating state information from said power distribution subsystem.

22. The remote user interface system of claim 12 wherein said remote browser application is an internet web browser application.

23. A method of controlling a telecommunications power system, comprising:
delivering an executable applet to a browser application running on a computer that communicates with said telecommunications power system via a network;
using a processor powered by said power system to obtain operating state information about said power system;
communicating said state information to said applet via said network;
sending control information generated by said applet to said processor via said network; and
using said control information to change the operating state of said power system.

24. The method of claim 23 further comprising using said processor to store said state information in a database administered by said processor.

25. The method of claim 23 further comprising using said processor to store said control information generated by said applet in a database administered by said processor.

26. The method of claim 23 further comprising generating a user interface display within said browser application that includes said state information.

27. The method of claim 23 further comprising generating a user interface display within said browser application that includes static information and dynamic information, the dynamic information being based on said state information.

28. The method of claim 27 wherein said applet generates a plurality of display screens in which at least a portion of said dynamic information on one of said display screens defines a hyperlink relationship with another of said display screens.

29. An automated upgrade analyzer for an electric power system of the type having one or more rectifier subsystems, one or more reserve power subsystems and one or more power distribution subsystems, comprising:

a monitor system coupled to said power system for obtaining operating state information from at least one of said subsystems;

a system expansion analysis module communicating with said monitor system, said analysis module having a data store containing at least one alarm threshold parameter and a processor for assessing said operating state information vis-à-vis said alarm threshold parameter; and

a user interface module communicating with said analysis module for providing upgrade notification with respect to a selected one of said subsystems before the capacity of said subsystem is reached.

30. The analyzer of claim 29 wherein said user interface module communicates over a network with an automated order processing host computer to requisition an upgrade component for said selected one of said subsystems.

31. The analyzer of claim 29 wherein said user interface module communicates over a network to send an electronic mail notification message regarding said selected one of said subsystems.

32. The analyzer of claim 29 wherein said user interface module communicates with a local display associated with said power system to provide an upgrade notification message.

33. The analyzer of claim 29 wherein said user interface module communicates over a network with a remote computer to provide an upgrade notification message for display by said remote computer.

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34. The analyzer of claim 29 wherein said user interface module communicates over a network with an applet running in a browser on a remote computer to provide an upgrade notification message for display by said remote computer.

35. The analyzer of claim 29 wherein said electric power system is of the type that employs at least one rechargeable storage battery and wherein said expansion analysis module assesses rectifier subsystem capacity based on total power output by said supply system, battery recharge time and battery size.

36. The analyzer of claim 29 wherein said electric power system is of the type that employs at least one rechargeable storage battery and wherein said expansion analysis module assesses capacity of said storage battery based on total power output by said supply system to a load.

37. The analyzer of claim 29 wherein said electric power system is of the type in which the power distribution subsystem provides connectivity for a predetermined number of load connections and wherein said expansion analysis module assesses power distribution subsystem capacity based on distribution unit load and the number of load connections.

38. The analyzer of claim 29 wherein said reserve power subsystem includes at least one reserve connection unit to which at least one rechargeable battery is attached and wherein said expansion analysis module assesses reserve power subsystem capacity based on the current flowing between said reserve connection unit and said battery.

39. The analyzer of claim 29 wherein said data store contains a first set of alarm threshold parameters representing over-capacity thresholds and a second set of warning threshold parameters representing user-defined capacity thresholds.

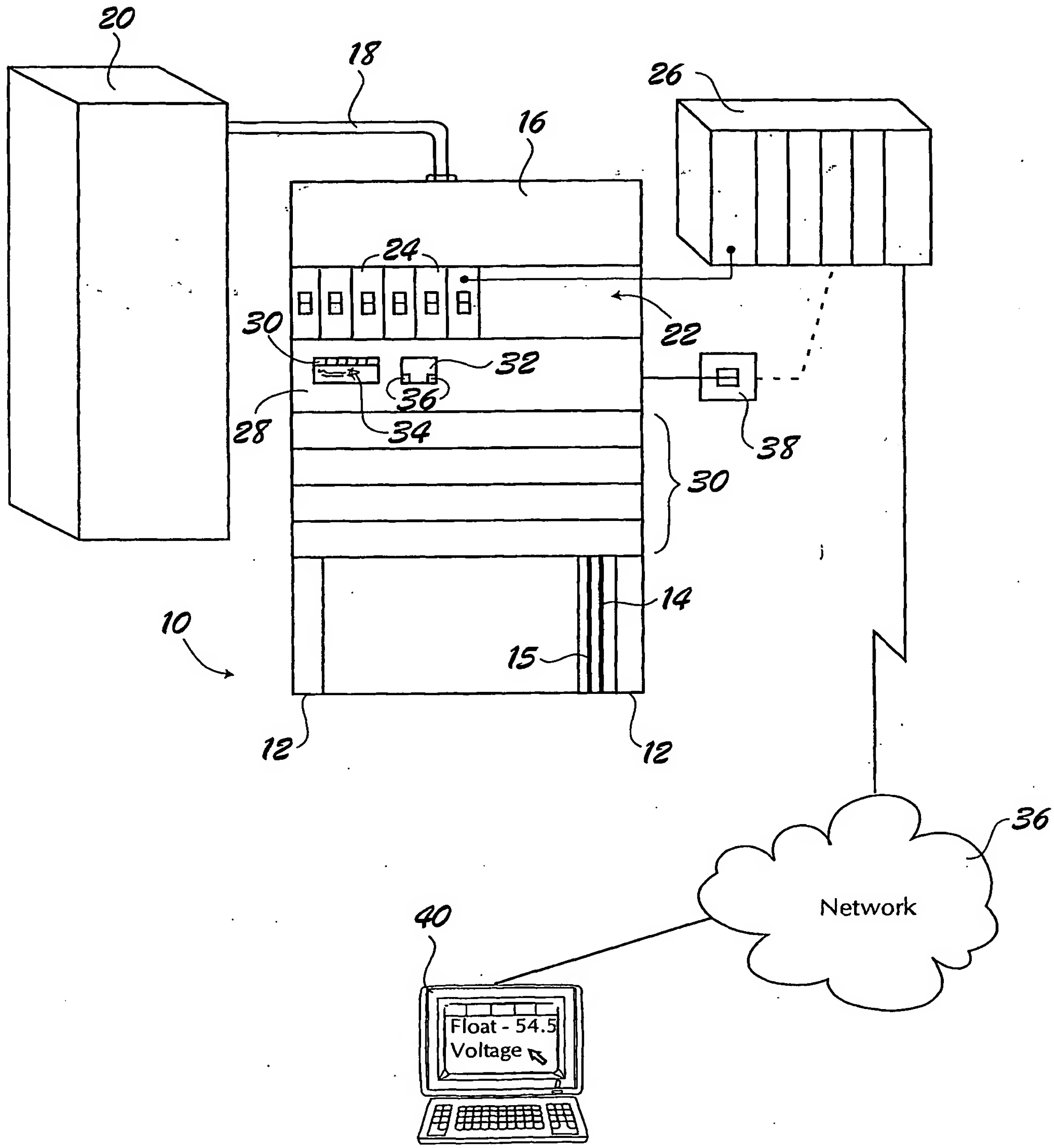

20
18
16
26
24
22
30
32
36
28
34
38
30
14
10
15
12
12
36
Network
40
Float - 54.5
Voltage

FIG. 1

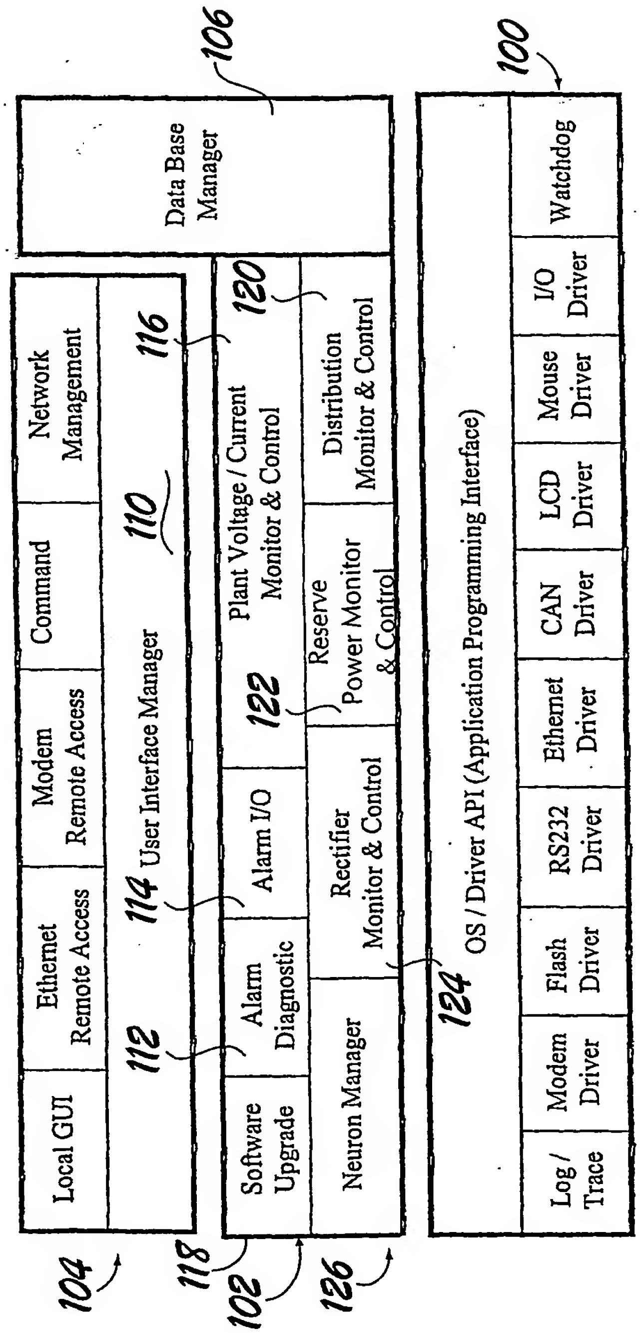

Data Base Manager
Local GUI
Ethernet Remote Access
Modem Remote Access
Command
Network Management
User Interface Manager
Software Upgrade
Alarm Diagnostic
Alarm I/O
Plant Voltage / Current Monitor & Control
Neuron Manager
Rectifier Monitor & Control
Reserve Power Monitor & Control
Distribution Monitor & Control
OS / Driver API (Application Programming Interface)
Log / Trace
Modem Driver
Flash Driver
RS232 Driver
Ethernet Driver
CAN Driver
LCD Driver
Mouse Driver
I/O Driver
Watchdog
100
102
104
106
110
112
114
116
118
120
122
124
126

FIG. 2

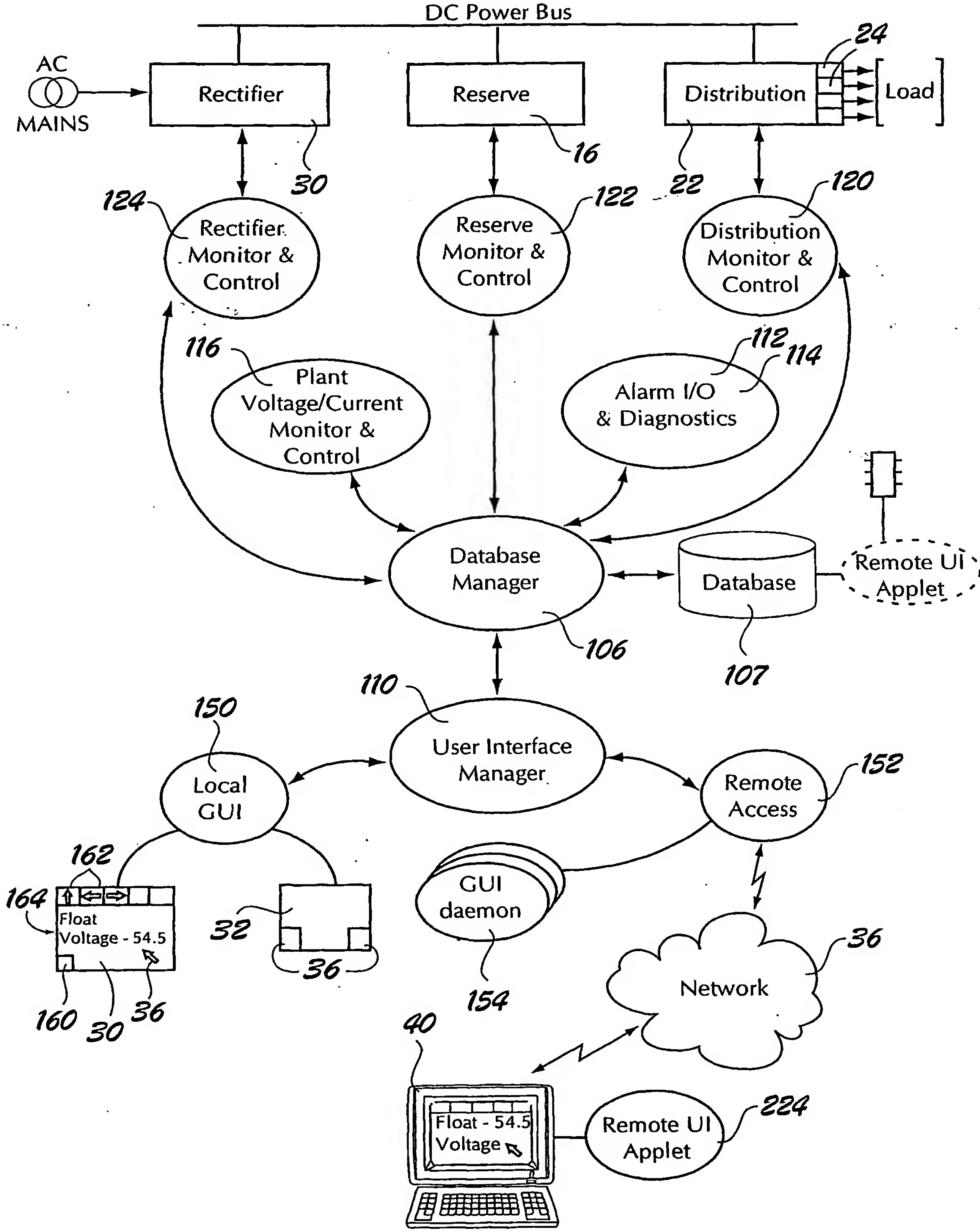

DC Power Bus
AC
MAINS
Rectifier
Reserve
Distribution
Load
24
30
16
22
124
Rectifier Monitor & Control
Reserve Monitor & Control
122
Distribution Monitor & Control
120
116
Plant Voltage/Current Monitor & Control
Alarm I/O & Diagnostics
112
114
Database Manager
Database
Remote UI Applet
106
107
110
User Interface Manager
150
Local GUI
Remote Access
152
162
164
Float Voltage - 54.5
160
30
36
32
36
GUI daemon
154
Network
36
40
Float - 54.5 Voltage
Remote UI Applet
224

FIG. 3

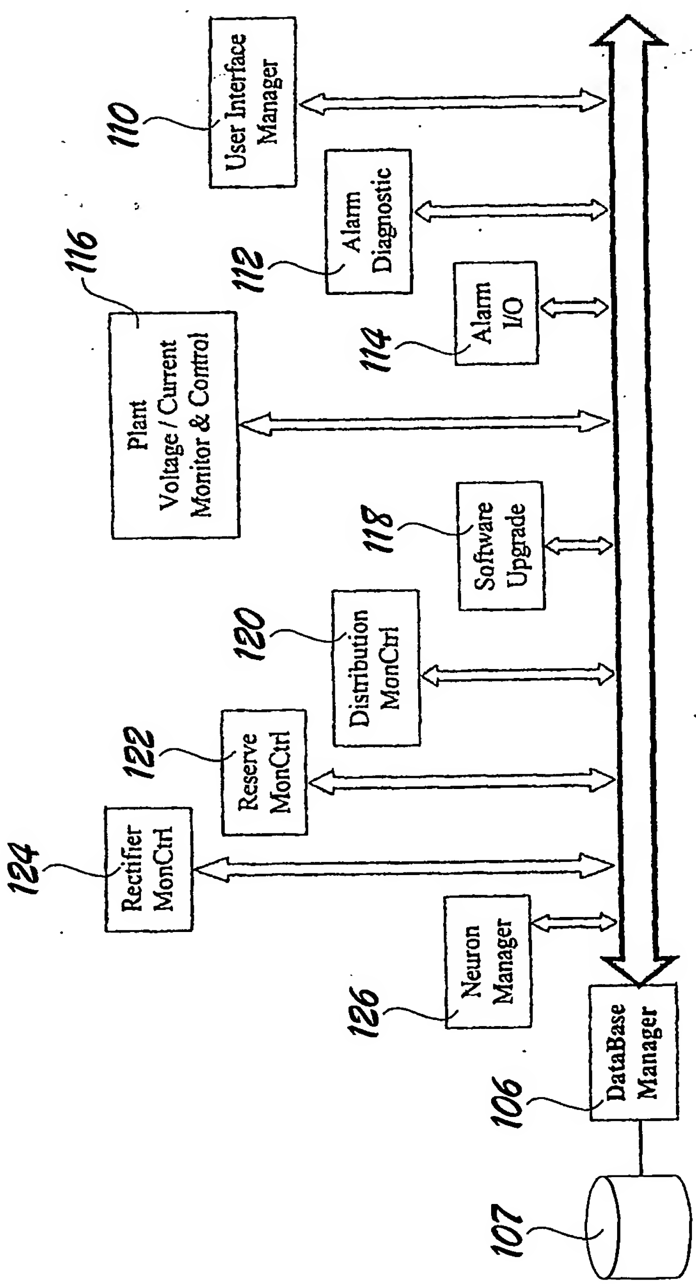

110
User Interface Manager
112
Alarm Diagnostic
114
Alarm I/O
116
Plant Voltage / Current Monitor & Control
118
Software Upgrade
120
Distribution MonCtrl
122
Reserve MonCtrl
124
Rectifier MonCtrl
126
Neuron Manager
106
DataBase Manager
107

FIG. 4

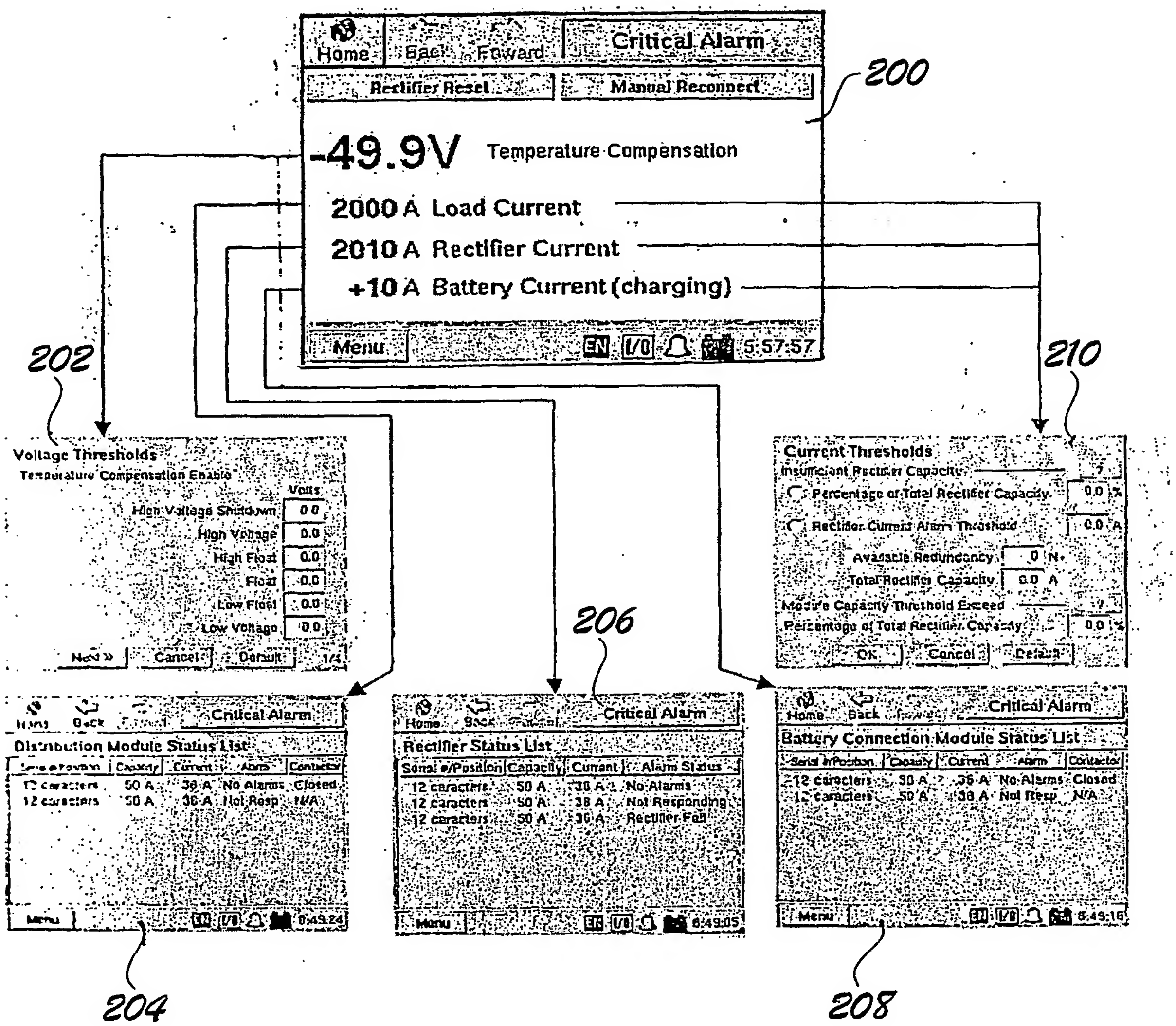

Home
Back
Foward
Critical Alarm
Rectifier Reset
Manual Reconnect
200
-49.9V Temperature Compensation
2000 A Load Current
2010 A Rectifier Current
+10 A Battery Current (charging)
Menu
EN
I/O
5:57:57
202
210
Voltage Thresholds
Temperature Compensation Enable
Volts
High Voltage Shutdown 0.0
High Voltage 0.0
High Float 0.0
Float 0.0
Low Float 0.0
Low Voltage 0.0
Next »
Cancel
Default
1/4
Current Thresholds
Insufficient Rectifier Capacity
Percentage of Total Rectifier Capacity 0.0 %
Rectifier Current Alarm Threshold 0.0 A
Available Redundancy 0 N+
Total Rectifier Capacity 0.0 A
Percentage of Total Rectifier Capacity 0.0 %
OK
Cancel
Default
206
Critical Alarm
Distribution Module Status List
Capacity
Current
Alarm
Contactor
50 A
38 A
No Alarms
Closed
12 characters
50 A
36 A
Not Resp
N/A
Menu
6:49:24
Home
Back
Critical Alarm
Rectifier Status List
Serial #/Position
Capacity
Current
Alarm Status
12 characters
50 A
38 A
No Alarms
12 caracters
50 A
38 A
Not Responding
12 caracters
50 A
36 A
Rectifier Fail
Menu
EN
I/O
6:49:05
Home
Back
Critical Alarm
Battery Connection Module Status List
Current
Alarm
Contactor
12 caracters
50 A
36 A
No Alarms
Closed
50 A
38 A
Not Resp
N/A
Menu
6:49:16
204
208

FIG. 5

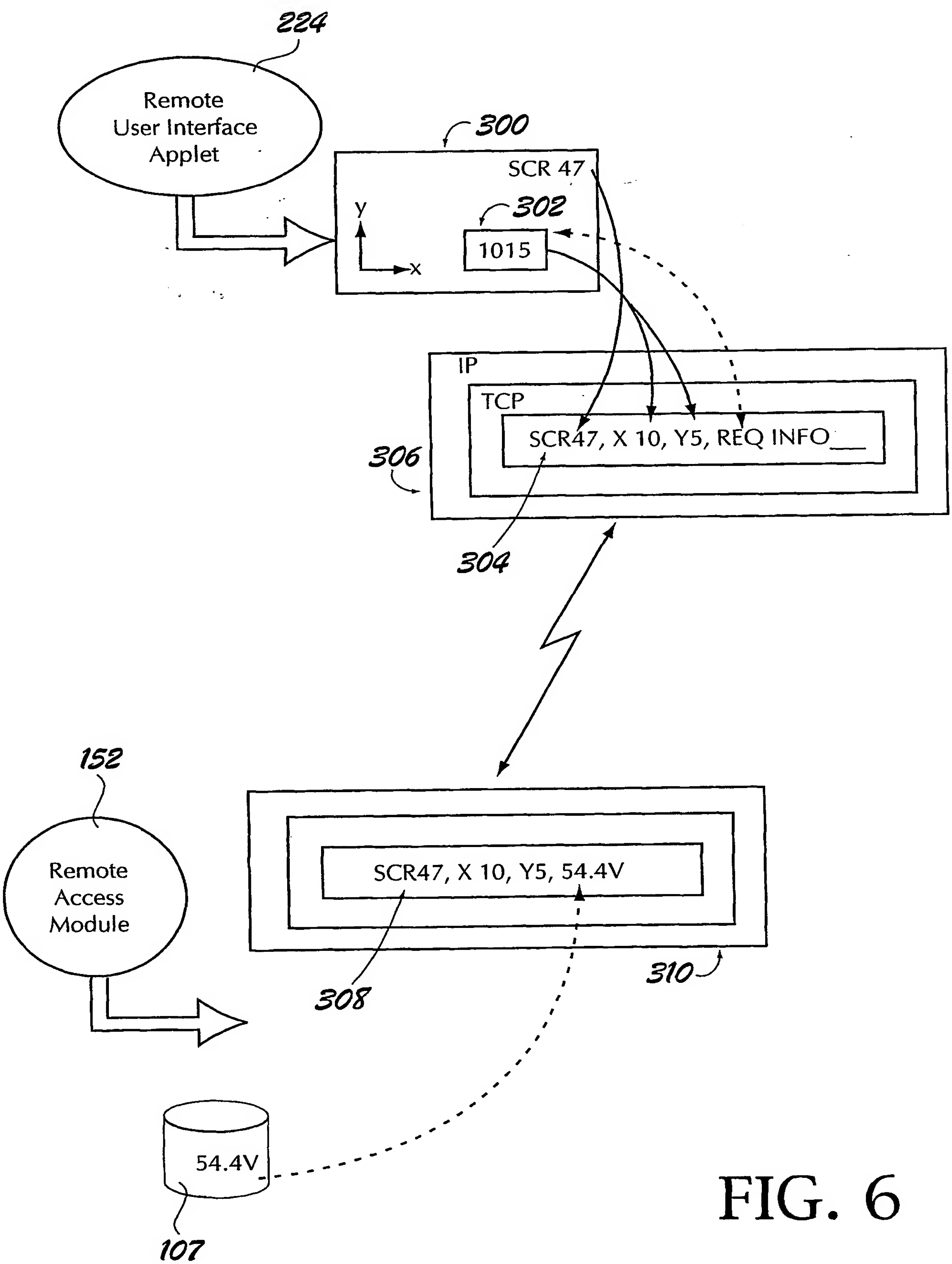

224
Remote User Interface Applet
300
SCR 47
302
y
x
1015
IP
TCP
SCR47, X 10, Y5, REQ INFO___
306
304
152
Remote Access Module
SCR47, X 10, Y5, 54.4V
310
308
54.4V
107

FIG. 6

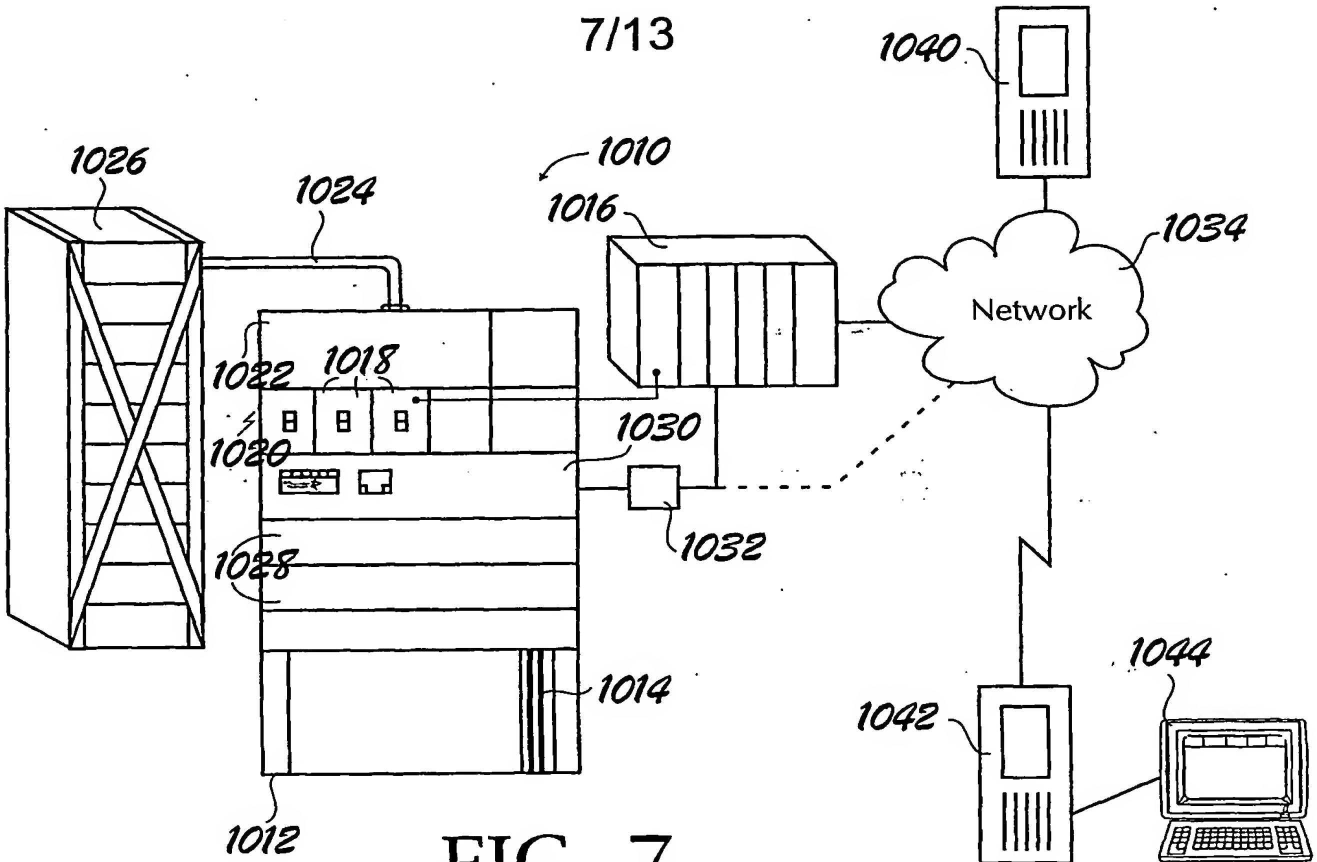

1040
1010
1026
1024
1016
1034
Network
1022
1018
1020
1030
1028
1032
1014
1044
1042
1012

FIG. 7

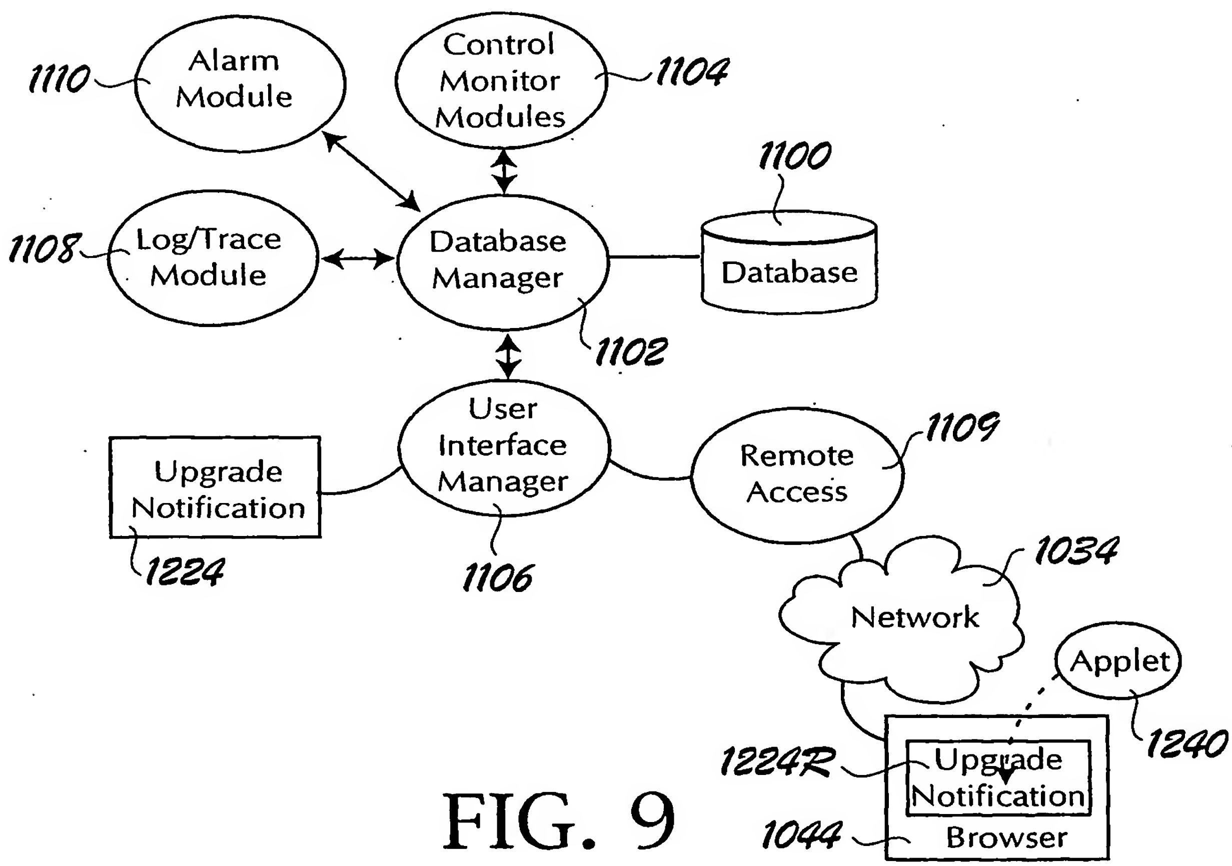

1110
Alarm Module
Control Monitor Modules
1104
1100
1108
Log/Trace Module
Database Manager
Database
1102
User Interface Manager
1109
Remote Access
Upgrade Notification
1224
1106
1034
Network
Applet
1240
1224R
Upgrade Notification
1044
Browser

FIG. 9

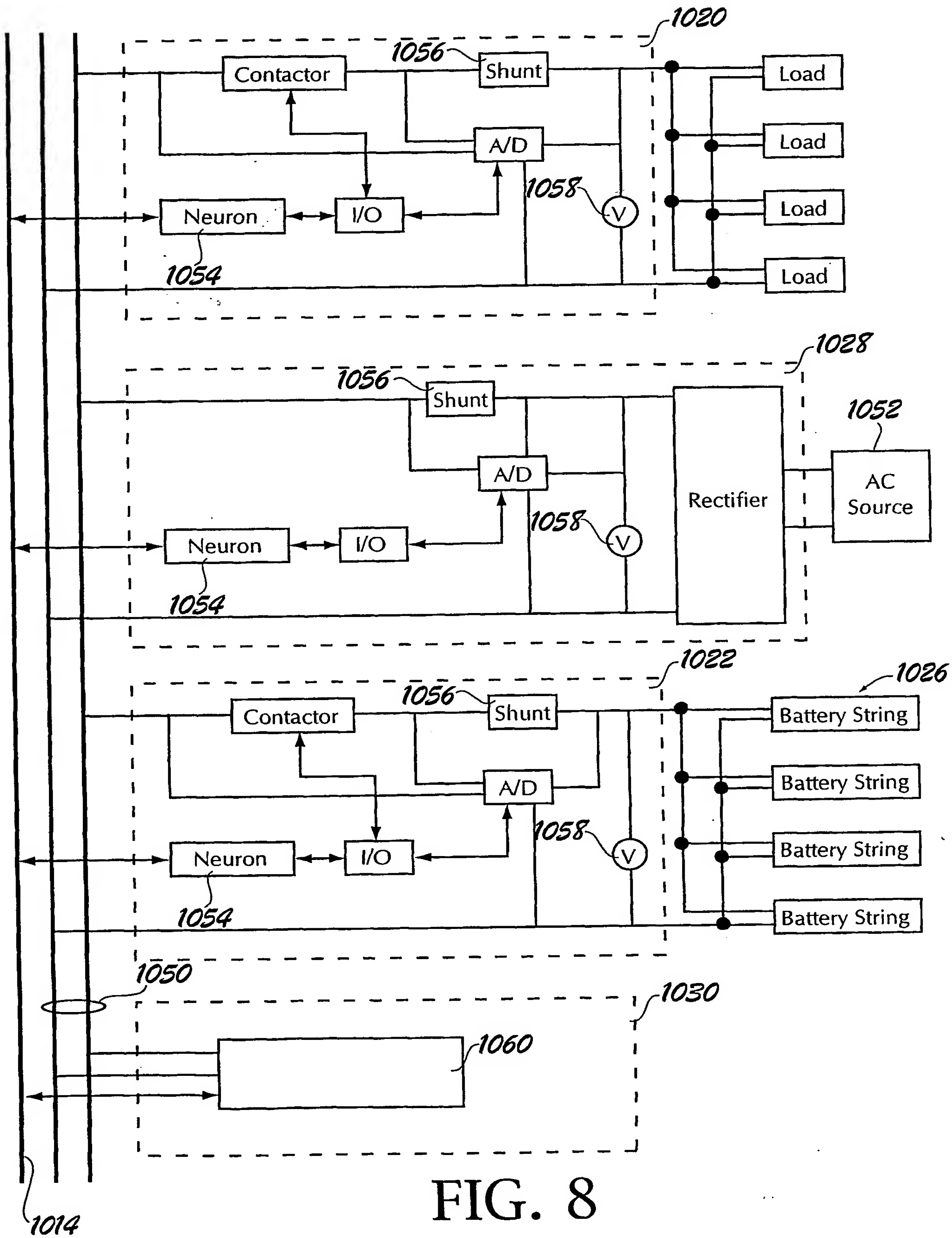

1020
1056
Contactor
Shunt
Load
Load
Load
Load
A/D
1058
V
Neuron
I/O
1054
1028
1056
Shunt
Rectifier
1052
AC Source
A/D
1058
V
Neuron
I/O
1054
1022
1026
1056
Contactor
Shunt
Battery String
Battery String
Battery String
Battery String
A/D
1058
V
Neuron
I/O
1054
1050
1030
1060
1014

FIG. 8

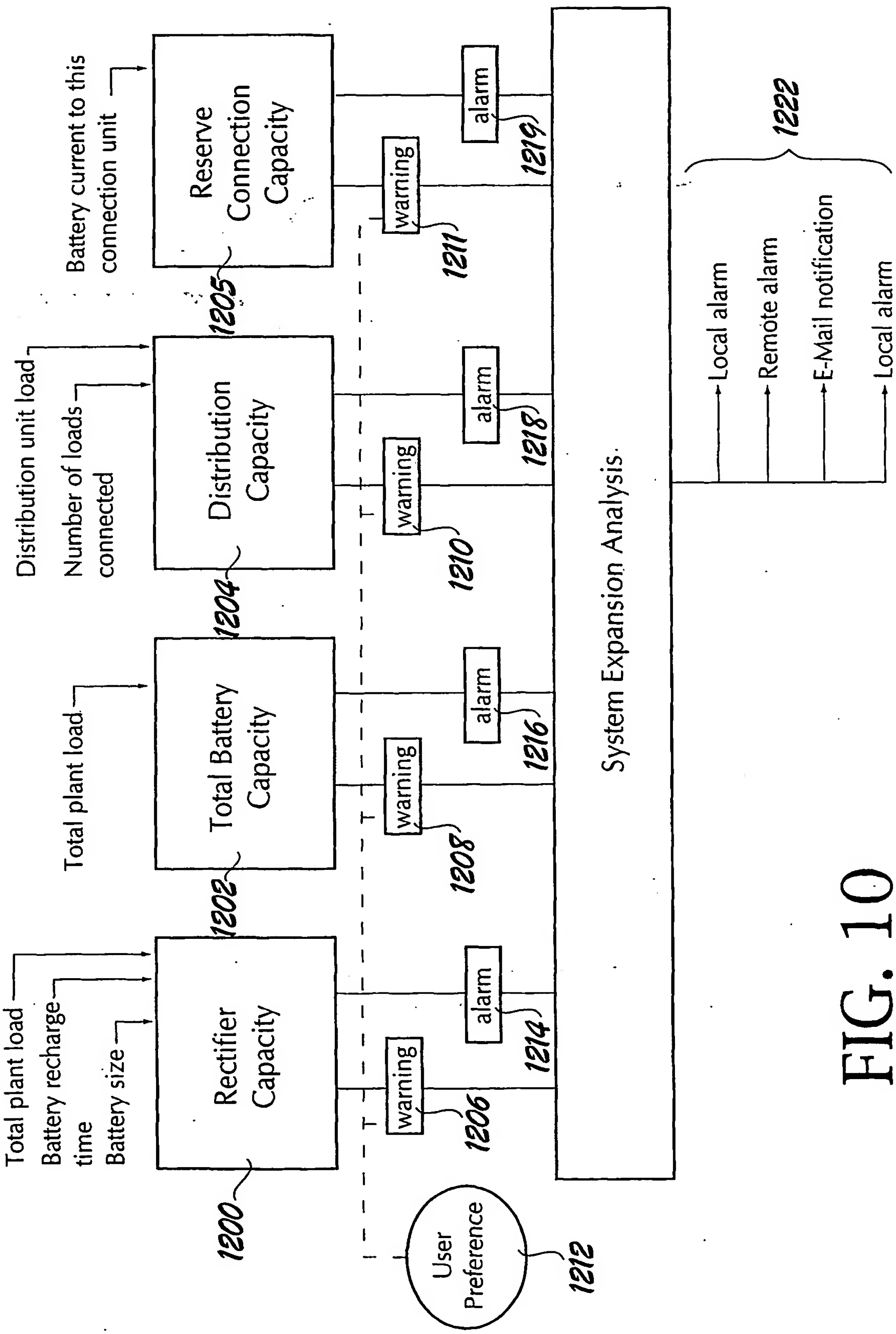
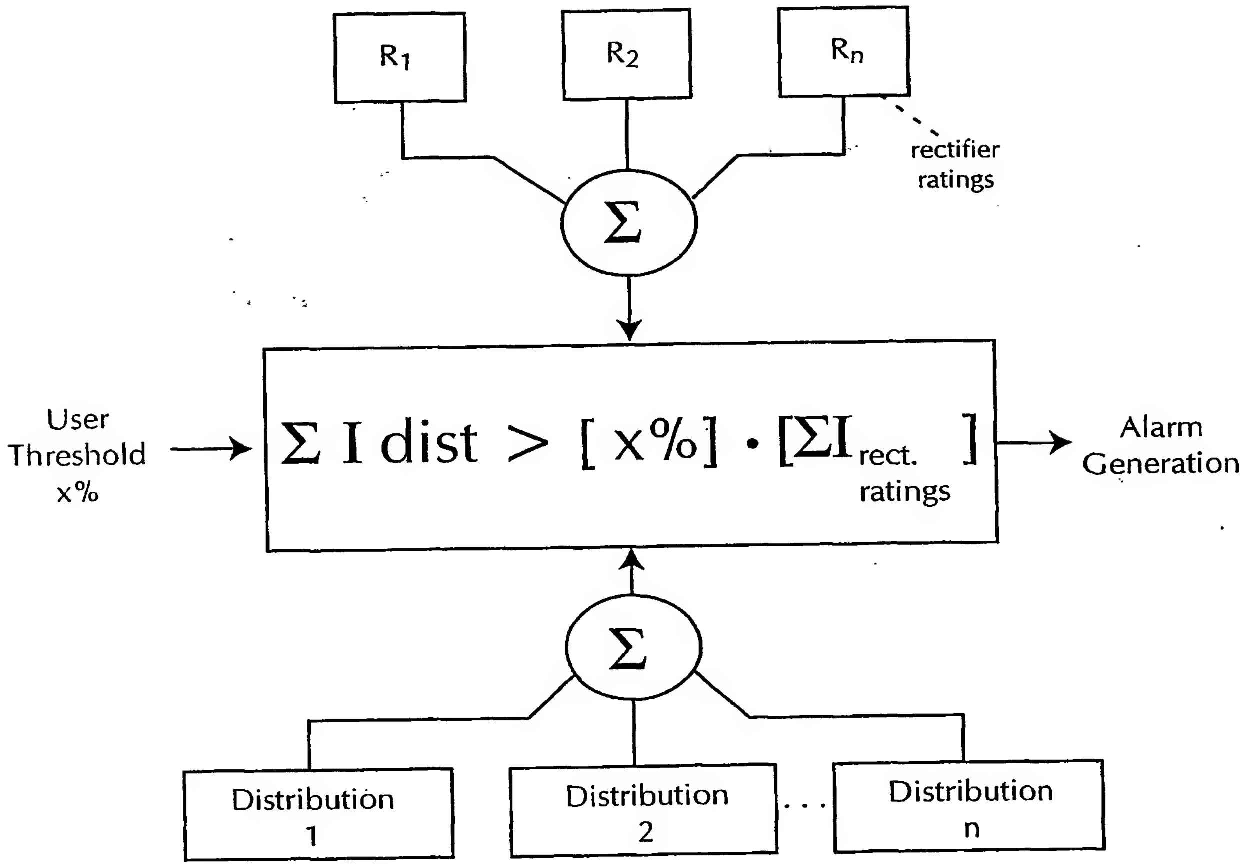

Total plant load
Battery recharge time
Battery size
Rectifier Capacity
1200
Total plant load
Total Battery Capacity
1202
Distribution unit load
Number of loads connected
Distribution Capacity
1204
Battery current to this connection unit
Reserve Connection Capacity
1205
warning
1206
alarm
1214
warning
1208
alarm
1216
warning
1210
alarm
1218
warning
1211
alarm
1219
User Preference
1212
System Expansion Analysis
1222
Local alarm
Remote alarm
E-Mail notification
Local alarm

FIG. 10



R1
R2
Rn
rectifier ratings
Σ
User Threshold x%
Σ I dist > [x%] • [ΣI rect. ratings]
Alarm Generation
Σ
Distribution 1
Distribution 2
Distribution n

FIG. 11

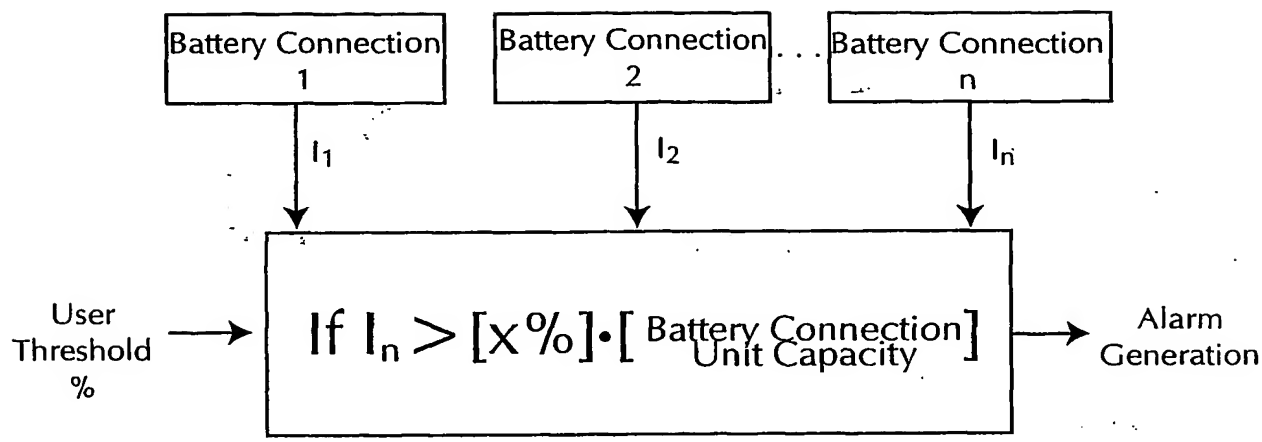

Battery Connection 1
Battery Connection 2
Battery Connection n
I_1
I_2
I_n
User Threshold %
If $I_n > [x\%] \cdot [\frac{\text{Battery Connection}}{\text{Unit Capacity}}]$
Alarm Generation

FIG. 12

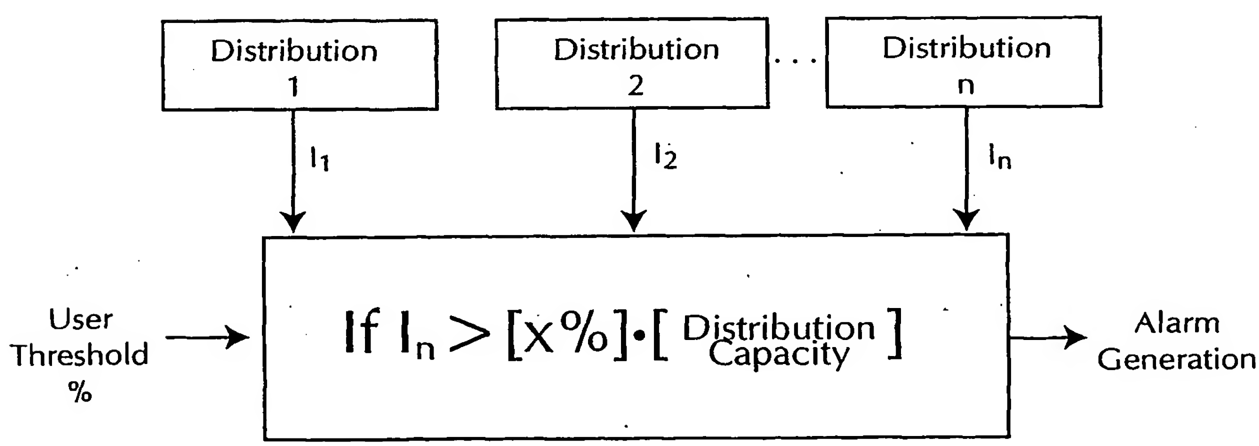

Distribution 1
Distribution 2
Distribution n
I_1
I_2
I_n
User Threshold %
If $I_n > [x\%] \cdot [\frac{\text{Distribution}}{\text{Capacity}}]$
Alarm Generation

FIG. 13

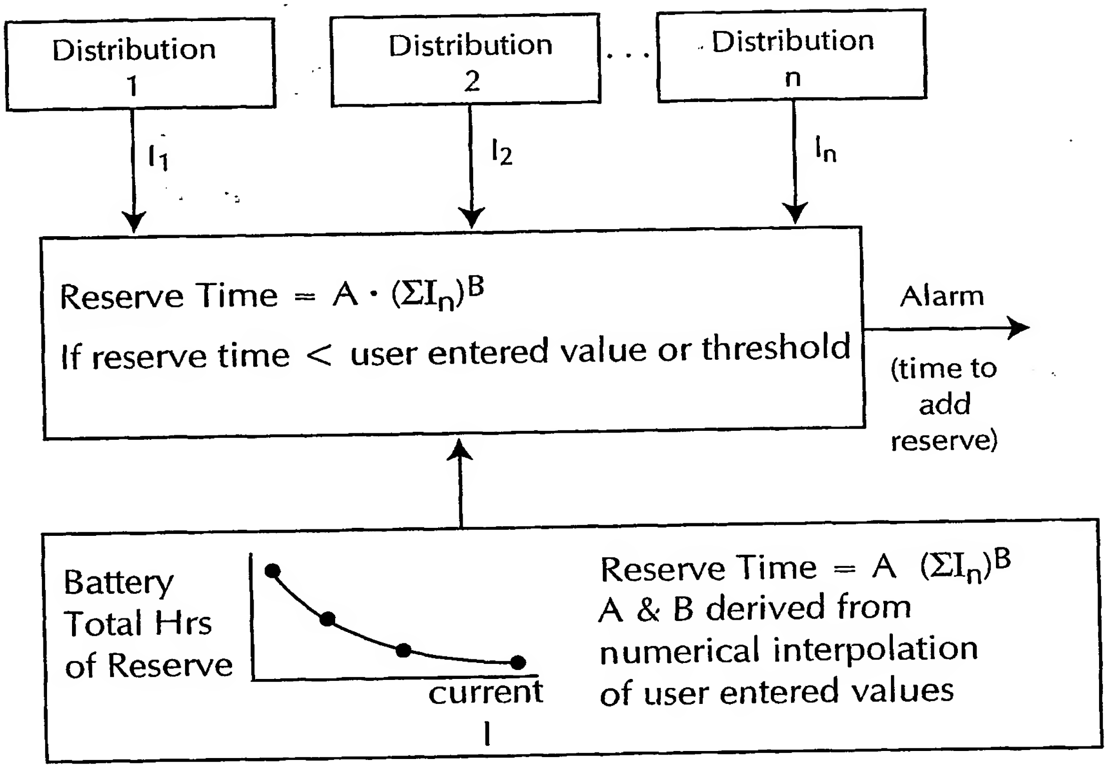

Distribution 1
Distribution 2
Distribution n
I_1
I_2
I_n
Reserve Time = $A \cdot (\Sigma I_n)^B$
If reserve time < user entered value or threshold
Alarm
(time to add reserve)
Battery Total Hrs of Reserve
current I
Reserve Time = $A \ (\Sigma I_n)^B$
A & B derived from numerical interpolation of user entered values

FIG. 14

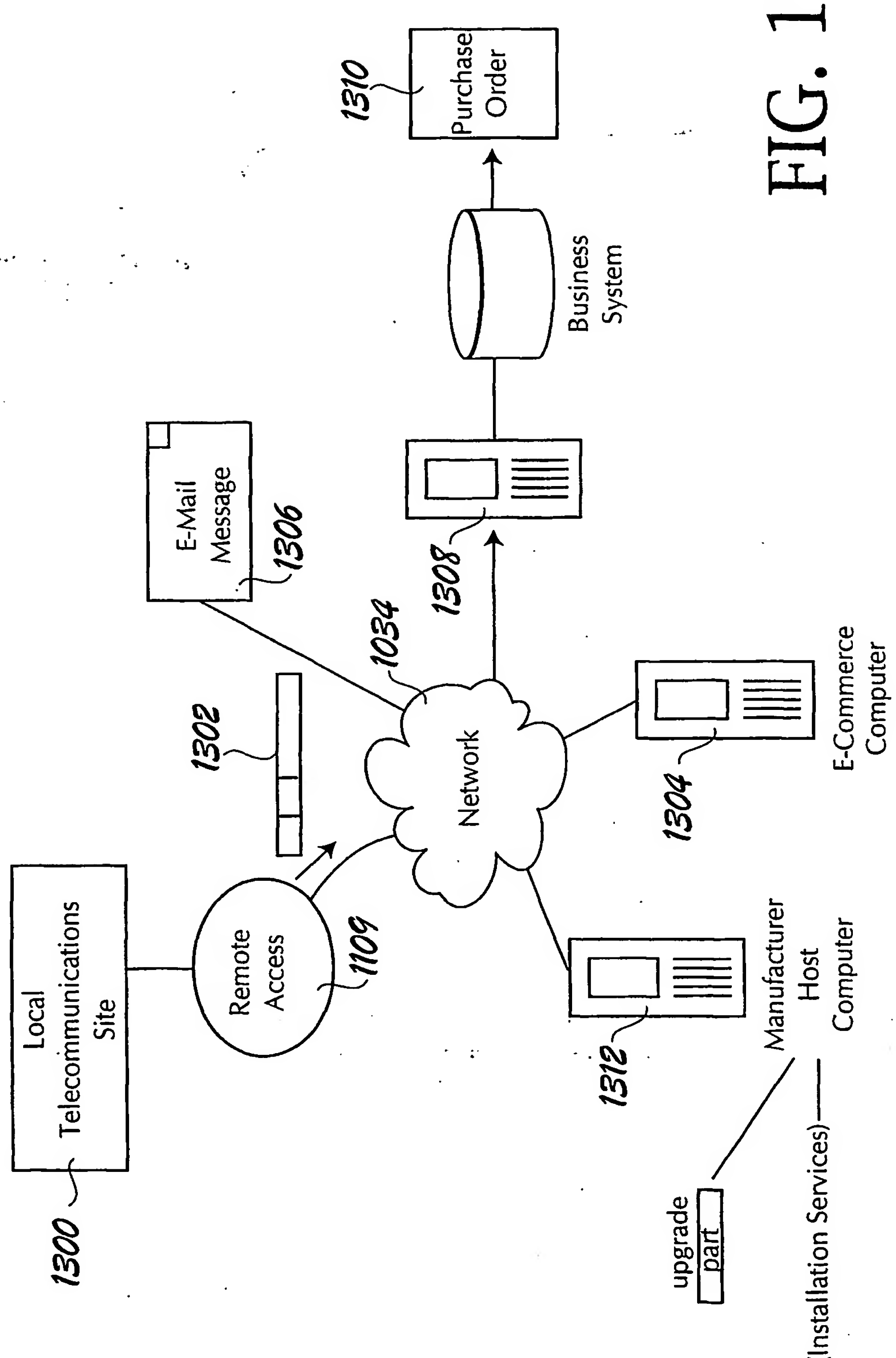

Local Telecommunications Site
1300
Remote Access
1109
1302
Network
1034
E-Mail Message
1306
1308
Business System
Purchase Order
1310
E-Commerce Computer
1304
Manufacturer Host Computer
1312
upgrade
part
(Installation Services)

FIG. 15

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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(71) Applicant *(for all designated States except US)*: **ASTEC INTERNATIONAL LIMITED** [CN/CN]; 17/F, Lu Plaza, 2 Wing Yip Street, Kwun Tong, Kowloon, Hong Kong (SAR) (CN).

(71) Applicants and
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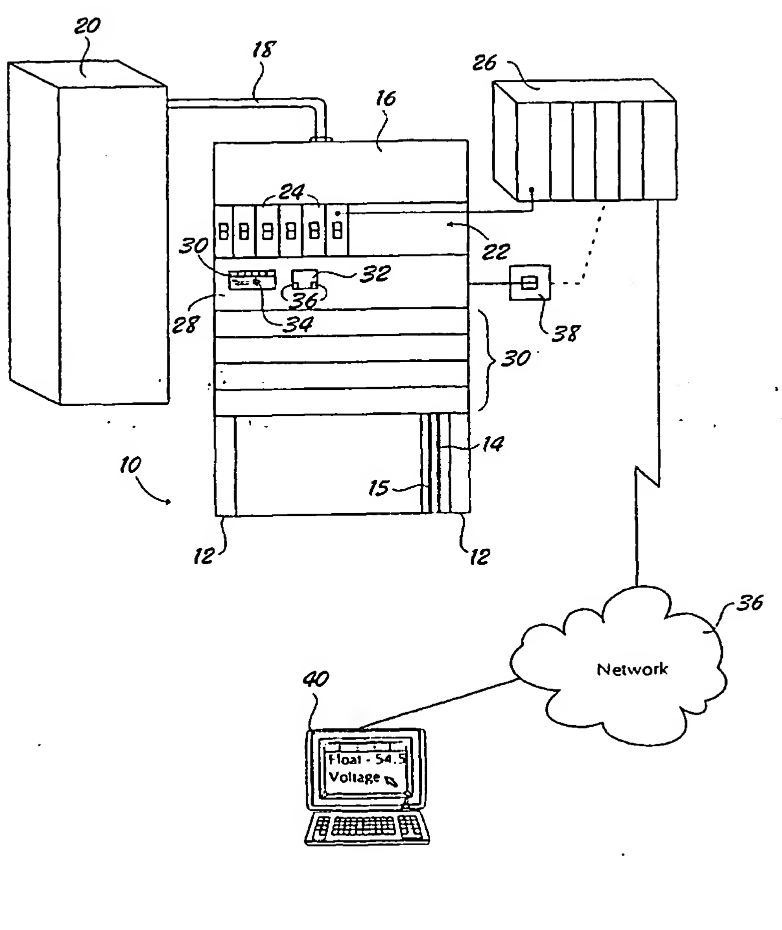
(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: **LAVERGNE, Marc** [CA/CA]; 1092 Des Azalees, Ste-Dorothee, Québec H7Y 2C9 (CA).

(74) Agent: **MACRAE & CO.**; P.O. Box 806, Station B, Ottawa, Ontario K1P 5T4 (CA).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,

[Continued on next page]

(54) Title: BROWSER-ENABLED REMOTE USER INTERFACE FOR TELECOMMUNICATIONS POWER SYSTEMS



(57) Abstract: The modular master control unit of the telecommunications power system communicates via a data bus with the associated modular rectifier units, distribution unit(s) and battery connection unit(s) to collect operating state information from the neuron processors of those units and store that information in a database. The master control unit also controls the operation of the associated modular units by supplying operating state information, based on values stored in the database. The user interface manager module provides local user interface control over the system by allowing the user through a local display screen and touch pad to read from and write to the database. By downloading an applet to a remote computer running a web browser, the user interface manager allows users at remote locations to perform the same control and monitor functions as a user at the local site. The applet runs within the standard browser and communicates with the user interface manager using TCP/IP protocol..

WO 01/093399 A3

CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

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Published:
- *with international search report*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 01/00809

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H02J9/06 G05B19/418 G05B19/05

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H02J G05B H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 982 652 A (SIMONELLI ET AL.) 9 November 1999 (1999-11-09) column 4, line 36-44 column 6, line 14-59 column 8, line 5-49; figures 2,6,8-10	1,2, 5-13, 16-28
A	column 1, line 55 -column 3, line 10 column 3, line 44-54 column 4, line 36-44 column 4, line 66 -column 5, line 16 column 6, line 14-40 column 8, line 5-34 column 12, line 49-61; figures 6-10 --- -/--	29

[X] Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search	Date of mailing of the international search report
23 July 2002	09. 08. 2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Beitner, M

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 01/00809

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Y	EP 0 825 506 A (FOXBORO CORPORATION) 25 February 1998 (1998-02-25) abstract column 1, line 49 -column 2, line 16 column 2, line 32 -column 5, line 35 column 6, line 57 -column 7, line 18 column 7, line 47 -column 8, line 14; figure 1 ---	1,2, 5-13, 16-28
A	US 6 061 603 A (PAPADOPOULOS ET AL.) 9 May 2000 (2000-05-09) abstract column 3, line 32 -column 4, line 50; figures 1,2 ---	1,2,5-7, 11-13, 16-18,22
A	WO 98 53581 A (COACTIVE NETWORKS, INC.) 26 November 1998 (1998-11-26) abstract page 1, line 13-31 page 3, line 13 -page 6, line 4 page 7, line 24 -page 10, line 31; figures 1,2 ---	1,2,5-7, 11-13, 16-18,22
A	WO 97 18636 A (WEBTRONICS, INC.) 22 May 1997 (1997-05-22) abstract page 1, line 20 -page 2, line 12 page 3, line 4-18 page 3, line 27 -page 4, line 28 page 5, line 12 -page 7, line 16; figures 1,3 ---	1,3,5, 11,12, 14,16,22
E	US 2002/001051 A1 (CRATTY) 3 January 2002 (2002-01-03) page 2, paragraph 21	29
A	& WO 99 60687 A (CANTOR) 25 November 1999 (1999-11-25) ---	29
A	US 5 371 666 A (MILLER) 6 December 1994 (1994-12-06) abstract column 2, line 31-49 column 3, line 38-41 column 8, line 8-36 column 16, line 23-50; figures 1,2,13 --- -/--	29

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 01/00809

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 673 826 A (MASSON) 16 June 1987 (1987-06-16) column 1, line 26-43 column 2, line 1-4 column 3, line 47 -column 4, line 11; figures 1,2 -----	29

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BNSDOCID: <WO________0193399A3_I_>

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA 01/00809

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

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☐ The additional search fees were accompanied by the applicant's protest.

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FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-28

   A remote user interface based on an INTERNET Browser to control and monitor telecommunications power supply systems

2. Claims: 29-39

   An automated upgrade analyzer for a telecommunications power system incorporating a user interface module for communicating over a network with a remote host computer

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/CA 01/00809

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 5982652	A	09-11-1999	US	6201319	B1	13-03-2001
			US	2001011845	A1	09-08-2001
EP 825506	A	25-02-1998	EP	0825506	A2	25-02-1998
US 6061603	A	09-05-2000	US	6282454	B1	28-08-2001
			EP	0937289	A1	25-08-1999
			JP	2001506104	T	08-05-2001
			WO	9913418	A1	18-03-1999
			US	6151625	A	21-11-2000
			US	2002091784	A1	11-07-2002
			US	2001003804	A1	14-06-2001
WO 9853581	A	26-11-1998	EP	1013047	A1	28-06-2000
			JP	2002512758	T	23-04-2002
			WO	9853581	A1	26-11-1998
WO 9718636	A	22-05-1997	AU	7706596	A	05-06-1997
			WO	9718636	A2	22-05-1997
US 2002001051	A1	03-01-2002	NONE			
US 5371666	A	06-12-1994	NONE			
US 4673826	A	16-06-1987	NONE			

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